Multi Sensor Correlation

Performance Analysis

for U.S. Navy

P3 Update IV

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MULTI SENSOR CORRELATION PERFORMANCE ANALYSIS FOR U.S. NAVY P3 UPDATE IV

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1.0 INTRODUCTION

1.1 Multi-Sensor Correlation Overview

Multi-Sensor Correlation is a method of integrating P-3 sensor data during Anti-Surface Ship Warfare (ASuW) and Anti-Submarine Warfare (ASW) missions.

ASuW and ASW missions involve detecting, localizing, tracking and collecting intelligence on surface and subsurface targets. The problem can be complicated by a number of factors:

- The target of interest can be masked by noise, frequently including noise generated by surface vessels of non-interest.
- Valid detections can be sparse and can contain ambiguous information.
- The aircraft must sometimes fly at a stand off distance or minimize the number of passes in order to remain covert.
- Time may be limited due to a long transit, a large search area or a hostile environment.

The aircraft crew must develop a clear tactical picture, as quickly as possible. Current mission avionics do not support integration of sensor data to achieve a concise tactical plot. This deficiency levies a burden on the aircrew, requiring that they analyze separate contact reports from each sensor for each target, and extract and maintain a usable picture. This is time consuming and diverts attention from primary objectives.

To address this situation, Boeing Aircraft Company, was contracted to include algorithms in the Update IV operational program which calculate and monitor correlations of contact reports or tracks with other contact reports or tracks. This capability is known as Multi-Sensor Correlation.

1.2 MSC Test Goals and Objectives

Overall, the goal of the Update IV Multi-Sensor Correlation Performance test effort was to verify the effectiveness of the MSC capabilities and their potential to enhance

operator performance on Anti-Surface Ship Warfare (ASuW) and Anti-Submarine Warfare (ASW) missions. The two main objectives of this effort were (1) to determine if correlations were made correctly and (2) to determine whether the position and velocity accuracy of a correctly correlated (fused) track was an improvement over the best of its components.

1.3 Purpose

The purpose of this report is to present a summary of the tests performed on the MSC algorithms and an evaluation of the test results. To evaluate the usefulness of MSC, its algorithms were measured using a software testbed which simulated aircraft and targets in a controlled laboratory environment.

Multi-Sensor Correlation algorithm evaluation success/failure results were analyzed by the following criteria:

- Type I and Type II Error Statistics (Type Error Analysis)

  Type I and Type II error probabilities were computed and recorded. A failure to correlate constitutes a Type I error (a missed correlation), and an incorrect (false) correlation constitutes a Type II error. These error probabilities quantify the performance of the correlation/ decorrelation tests.

  Type I and Type II error recoveries were also computed and recorded. A Type I error recovery is the span (in track updates) from the time two different sensor tracks from the same target failed to correlate to the time they were correlated. A Type II error recovery is the span in track updates from the time that sensor tracks from different targets correlated to the time the errant fused track decorrelated. In the case where fused tracks are not accepted, the recovery takes place either when the same pair of fused components fails to correlate or when one of the components correlates with a different track which is incompatible with the original correlation. The incompatibility is bases on the two tracks being based on their same sensor.

- Fused Accuracy Analysis

  This analysis provides statistics on the accuracy performance of fused tracks versus their components. The specific requirement being tested was whether

the fused track accuracy is as good or better than the best of its components.

More detailed information about MSC algorithms which were tested can be found in Section 3.2 of this report.

1.4 Test Methodology

In general, the tests were conducted as follows:

a. Select and prepare test input data for producing test scenarios, eg. aircraft altitude, platform type, target speed, target heading and sensor type, etc.
b. Generate testbed scenario files using the Automatic Test Scenario Generator (ATSG) which will exercise a particular MSC test case. Each scenario file has a unique random number series which determines the sensor error perturbation.
c. Load the scenario files into the Update IV Testbed and execute the testbed for each input test scenario file.
d. Analyze Testbed results and ATSG extractions by using an MSC Test Results Analysis Program which produces reports and plots the results of each test.

1.5 MSC Test Constraints

Some constraints were necessary since MSC algorithms were evaluated using a simulated operational environment. The first one related to sensor selection by sensor covariance. It is described in Section 1.5.1. The second constraint related to track additions and updates. Generally, conflicts arose when a new track was added after other tracks had already updated. Therefore, all new track additions were done before any track updates. This is discussed further in Section 1.5.2.

1.5.1 Sensor Covariance

Sensor selection was based on the sensor covariance. Five sensors were implemented in the ATSG scenario generator. The sensors which are available for Multi-Sensor Correlation and those which were considered as part of the MSC test effort are listed as follows:

MAD

The covariance is a very small, fixed value and represents a moderately oblong ellipse. ATSG used sigmas 66.17 ft for latitude variance and 93.41 ft for longitude variance.

IRDS

The true covariance is based on classified data. The covariance used was based on unclassified interim test parameters provided in the Update IV software. These (or any reasonable parameter set) produce occasions with very oblong covariance ellipses. As a result, test performance is very erratic inviting scrutiny not warranted in view of the interim test parameters being used for perturbation. Therefore, formal testing of IRDS is omitted from the scope of this study.

Track-While-Scan (TWS) Radar and Manual Radar

These sensors use a common tracking algorithm and, as such, are identical in performance. They are also incompatible in the same scenario, so they cannot be correlated. The radar covariance can become quite oblong at extreme distances. The following is the ATSG logic that simulates realistic perturbation errors:

- Perturb the aircraft north-south position by adding a sample value from a normal distribution whose standard deviation is 19.4 feet. Do the same for the east-west position. This corresponds to a radar scale of 8 NM which is used in the stub code for variance generation.

- Perturb the range from the perturbed aircraft position to the target by adding a sample value from a normal distribution whose standard deviation is 100 feet.

- Perturb the bearing from the perturbed aircraft position to the target by adding a sample value from a normal distribution whose standard deviation is 0.2 degrees.

- Compute the perturbed target position by adding the perturbed range/bearing vector to the perturbed aircraft position.

Visual

The covariance is circular and based on P-3 aircraft altitude. The ATSG logic used to simulate realistic perturbation errors was to perturb the target north-

south position by adding a sample value from a normal distribution whose standard deviation is equal to aircraft altitude. Do the same for east-west position.

ESM

Not implemented in the ATSG scenario generator.

Acoustic

Not implemented in the ATSG scenario generator.

Data Link

Not implemented in the ATSG scenario generator.

MAD, radar and visual sensors were included within the scope of this MSC algorithm performance test effort. Inclusion of the remaining P-3 sensors into the MSC problem will be reserved for future MSC test efforts.

1.5.2 Alert Acceptance Delay Caused by Target Object Identification

Object Identification number (Object IDs) are used in the Update IV software to reference items in the data base. During addition of a new track to the database, a new object ID was created. Also, when two or more tracks were correlated(fused), a new object ID was created. The former objects were known, controlled and used by the ATSG as it builds the scenario file. The latter objects were created at the discretion of the testbed user by accepting an alert. The Update IV software expects the objects to be generated with sequential IDs. Since fusion events of the testbed were unpredictable in the production environment, a test scenario policy was necessary to avoid object ID conflicts. All new objects needed to be added up front in the scenario file, and the testbed user was required to delay correlation acceptance until all the new tracks were created. The ATSG policy was to not add any new tracks after track updates were added. The testbed policy was to reject correlation alerts for track additions. With these two policies, no new tracks could be added to the database after a fused object had been created. Thus, the testbed works correctly without object ID conflicts. Although target tracks are normally added at random times, the MSC results with the above constraints should remain valid.

1.6 Summary of MSC Test Results

- High rate of Type II errors

  The MSC test results show that the number of occurrences of Type I and II errors is dependent on target track separation relative to the sensor covariance matrix as expected.

- Good fused track performance.

  The expected accuracy of the correctly fused track was found to be an improvement over the best component by typically 10% for both position and velocity when only radar and visual are used. However, this relative accuracy often degrades when a MAD track is added. Using the more accurate MAD track, the relative performance was found to often degrade by as much as 30% for position and 20% for velocity compared to MAD. However, some of this degradation may be due to the failure (in the analysis) to properly represent the component track RMS errors at the time of the fusion. No projections in time were made to these sensor tracks so the sensor track RMS statistics only represented errors when they were updated, not when used for fusion at the time of another sensor update. Of the cases with correctly fused tracks excluding MAD, 100% had more improvements than degradations in the fused track relative to the best component. In the case where MAD was used as the third track, only 44% of the cases had more improvements than degradations. These results can be seen for specific runs in Tables in Section 5 and in greater detail in Section 6.

1.7 Reference Documents

(a) P-3 Update IV Multi-Sensor Correlation; May 1989 paper, Robert Fritz, Oricon Corporation

(b) Test Of Fusion Algorithm; 11 Jul 1989 memorandum #3620-89-059, Pat Kavanaugh, Oricon Corporation

(c) Multiple Target Tracking With Radar Applications; 1986 text, Samuel Blackman

(d) Evaluation of Mission Avionics Sensor Synergism (MASS) project; 1989-1991, NADC

(e) Implementation Of Branch And Bound For Realtime Processing; 21 Apr 1989 memorandum, William Bailey, NADC

(f) Fuzzy Logic Concepts For Multi-Sensor Tracking; 1993 Independent Research project, Dr. Ram Singh, William Bailey, NAWC

(g) Multitarget-Multisensor Tracking; 1990 text, Yaakov Bar-Shalom editor

(h) Automatic Testbed Scenario Generator Users' Manual, Intermetrics Inc.

(i) Software Users Manual, Testbed, D385-66117-1

(j) Software Requirements Specification, Tactical Mission System, SW385-66620-1

(k) Automatic Testbed Scenario Generation, Users' Manual, Revision 2, Intermetrics, Inc, Warminster, PA Dec 31, 1992

2.0 TEST PLAN

2.1 Test Plan Overview

The areas documented in this section include the following:

- Algorithms to be tested and evaluated
- Test parameters to be selected and varied

2.1.1 Algorithms to Be Tested

Three algorithms will be verified: correlation, data fusion, and track update. The following is a hierarchical listing:

a. Multi-Sensor Correlation Test
  (1) Classification Tests
    (a) Type Test
    (b) Class Test
    (c) Platform Test
    (d) Classification Score
  (2) Geometric Correlation Tests
    (a) Track-to-Track Correlation Test
    (b) Track-to-Position Correlation Test
    (c) Track-to-Bearing Correlation Test
    (d) Track-to-Range Correlation Test
    (e) Position-to-Position Correlation Test
    (f) Position-to-Bearing Correlation Test
    (g) Position-to-Range Correlation Test
  (3) Threshold Analysis
    (a) Classification Correlation Analysis
    (b) Geometric Correlation Analysis
    (c) Selection

b. Multi-Sensor Data Fusion
  (1) Classification Fusion
  2) Geometric Fusion
    (a) Track-to-Track Fusion
    (b) Track-to-Measurement Fusion

(c) Measurement-to-Measurement Fusion

c. Multi-Sensor Track Update
   (1) Classification Decorrelation Test
   (2) Geometric Decorrelation Test
   (3) Threshold Analysis
   (4) Classification Update
   (5) Geometric Update

2.1.1.1 Multi-Sensor Correlation Test

The purpose of the Multi-Sensor Correlation Test is to test for correlation of new and updated contact reports or tracks with existing objects in the tactical database. In the automatic (AUTO) correlation mode, a new or updated sensor contact, component track or fused track is tested for correlation with all other objects in the tactical database. In the manual mode, this function is scheduled when the operator makes a request to correlate a pair of objects. This function correlates two tactical objects based on their classifications, geometric relationship, and threshold constants. For this study, only the AUTO correlation mode was used. Testbed operation was hands off/policy driven. Two policies were tested; 1.) "reject all" correlation alerts and 2.) "accept all" correlation alerts except those from additions to the data base. Split track alerts (which occur only for the latter case) were always accepted.

2.1.1.1.1 Classification Tests

The Classification Tests perform Boolean comparisons on three characteristics of the contacts/tracks and accumulate the results. The three characteristics are Type (air, surface, subsurface, unknown), Class (hostile, friendly, unknown) and Platform (NATO class identifier). The accumulation of the results into a single score is done by the Classification Score subfunction. This was tested informally and found to function properly to support the thrust of this study which is geometric in nature.

2.1.1.1.2 Geometric Correlation Tests

The purpose of the Geometric Correlation Tests is to use the geometric parameters of the contacts/tracks to construct a chi-square statistic whose value quantifies the possibility that the geometric information from the two contacts/tracks are from the same source. The statistic is computed as follows:

$$\text{chi-square} = [Xa-Xb]^T \, [Pa+Pb]^{-1} \, [Xa-Xb]$$

where, Xa and Xb are vectors of the objects' data elements (position,velocity), and Pa and Pb are the associated covariance matrices. The data from the two contacts/tracks must be synchronized in time and must be consistent with each other. Therefore, before the statistic is computed, the older data set is projected to the time of the more recent, and positions are translated into bearings or ranges, if necessary, for compatibility. The Chi-square statistic is a measure of geometric difference between two objects. A threshold for this value is used for the correlation decision.

2.1.1.1.3 Threshold Analysis

Threshold Analysis determines if the criteria for classification fusion and geometric fusion have been met. The Classification Correlation Analysis subfunction compares the output of the Classification Score subfunction - a number between 0 and 10 - to a threshold. With respect to geometric correlation, the Geometric Correlation Analysis subfunction calculates what is termed the chi-square score from the computed chi-square statistic and its associated chi-square density function. Chi-square is a statistic that is used to compare observed values against hypothetical values. The chi-square score is compared to a threshold. The Selection subfunction picks the "best" object pair from the ones that passed classification and geometric analysis.

2.1.1.2 Multi-Sensor Data Fusion

The purpose of Multi-Sensor Data Fusion is to generate a new, fused track from either a track-track pair, a track-contact report pair, or a contact report - contact report pair. This function fuses together classification and geometric data from the two contact/track objects.

2.1.1.2.1 Classification Fusion

Classification Fusion assigns values to the fused track's Type, Class and Platform parameters. It assigns the most specific value to the Type and/or Class parameter. The two component Platform lists of identifiers are logically merged to form the new list.

2.1.1.2.2 Geometric Fusion

Geometric Fusion creates a fused track from the two component objects. This subfunction uses the Kalman filter's time update and measurement update equations to calculate the track's initial state estimate and covariance matrix.

2.1.1.3 Multi-Sensor Track Update

The purpose of Multi-Sensor Track Update is to update the fused track when one of its contact report /track components is updated, and test for decorrelation among the components of that fused track. Subfunctions for Track Update are described below.

2.1.1.3.1 Classification Decorrelation Test

The Classification Decorrelation Test compares the classification state of the component being updated with the aggregate classification state of all the other components. If Type or Class fails to correlate, the component is decorrelated from the fused track. For example, a fused track of a "friendly" and "unknown" component would be decorrelated when the "unknown" becomes "hostile."

2.1.1.3.2 Geometric Decorrelation Test

The Geometric Decorrelation Test accomplishes its task by first updating the state and covariance matrix of the fused track to the time of the component contact report/track update. If necessary, it then translates the fused track position to a bearing or range to match the form of the data. The residual between the new data and fused track, and the combined new data and fused track covariances are then used to form a chi-square statistic.

2.1.1.3.3 Threshold Analysis

Threshold Analysis calculates what is termed a cumulative chi-square score from the geometric chi-square statistic. If the score is less than a threshold, the component contact/track is decorrelated from the fused track.

2.1.1.3.4 Classification Update

Classification Update uses the logic found above in Classification Fusion to reassign values to the fused track's Type, Class and Platform parameters.

2.1.1.3.5 Geometric Update

Geometric Update uses the logic found in Geometric Fusion to recalculate the fused track's state estimate and covariance matrix.

2.1.2 Test Parameters

The parameters below were varied over a range of values. A representative set of parameter combinations became test cases. For all cases tested, the sensor perturbation error was simulated to be compatible with the measurement covariances for the applicable sensor.

- True range from A/C to initial target position
- Frequency of each sensor update
- Sensor type combinations
- Aircraft altitude
- Target altitude
- Aircraft loiter pattern
- Target track pattern
- A/C to target track aspect (relationship of A/C vs target race track patterns)
- Target Speed
- Target separation
- Target transit maneuvering
- Multiple target track patterns
- Target Classifications

3.0 TEST SPECIFICS

3.1 Test Environment

The Testbed, the Automatic Test Scenario Generator (ATSG) and the MSC Test Results Analysis Program were the major software tools used to test and evaluate the MSC algorithms. The Testbed provided the framework for running the Update IV operational program in a laboratory environment, the ATSG generated inputs for the Testbed and the analysis program evaluated the results of the testbed runs. Figure 3.1 - 1 shows the data flow.

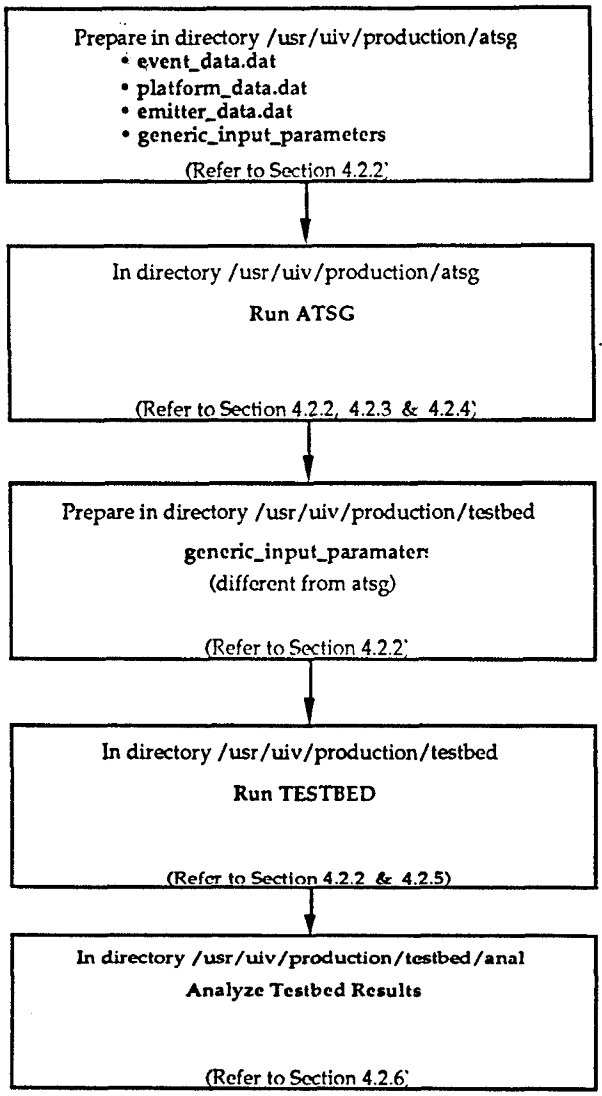

Figure 3.1 - 1 - Test Data Flow

These tools resided in a laboratory located at NAWCADWAR known as the Software Development Laboratory (SDL). The laboratory contained a network of SUN 3 and VAX computers running UNIX based operating systems and the VERDIX Ada Development System (VADS). The Testbed, ATSG and analysis program were developed in Ada and run on the SUN 3 computers. The Testbed was developed by Boeing Aircraft Company, and the ATSG was developed by Keystone Computer Associates, Inc. and Intermetrics, Inc. for NAWCADWAR.

3.2 Performance Measurement

The correlation algorithms were tested using simulated operational scenarios. A varied group of scenarios were employed; they are described in Tables 3 - 1 thru 3 - 5. Each scenario was run several times with random perturbed measurements. The scenarios were designed to measure performance in six categories. They are discussed below.

3.2.1 Correlation Performance

Correlation performance is how well new and updated contact reports or tracks fuse. Correlation performance was measured by counting the number and verifying the correctness of new and updated contact reports or tracks with existing objects in the tactical database.

3.2.1.1 Type I Error and Type II Error Count

This analysis provides statistics on the number of Type I and Type II errors. A Type I error occurs when the MSC algorithm fails to correlate when it should. A Type II error occurs when the MSC algorithm incorrectly correlates targets which are not truly the same. A plot was produced showing the accumulated percent of false and missed correlations by iteration; see Appendix A - Specific Test Results, A.2 Plots. The flatness, of this plot on the right indicates the degree of stability and therefore reproducibility of the test results. Sufficient stability was usually achieved in about 15 iterations.

In normal MSC operations, the user must respond to correlation and split track alerts. To eliminate the need for user interaction, the Mission Software was modified to permit either automatic rejection or automatic acceptance of all alerts.

These alert response modes were used for measuring different correlation aspects as follows:

a. Reject all
In this mode, all correlations are automatically rejected by the Testbed. Data is extracted to indicate whether objects are correlated. For the "Reject-all" case, error statistics are not masked by "lock-in" conditions due to apriori acceptance .

b. Accept all
In this mode, all alerted correlations are automatically accepted by the Testbed. Data is extracted to indicate whether objects are correlated and remain correlated. The alerts presented to the operator are reflected by the true and false correlation counts. For the "Accept-all" case, error statistics are biased by apriori acceptance of fused tracks. For example, when a correlation alert is accepted causing a fused track to be generated, all updates to the components to that fused track will be checked for continued compatibility with that fused track. Other fusion possibilities are masked by the apriori fusion. Note that in practice, the intervention of the operator can be expected to improve performance.

Figure 3.2.1.1 - 1 shows both the principles behind hypothesis testing and the definitions of Type I and Type II errors. A hypothesis test compares the value of a computed statistic to a threshold and decides to which probability distribution the statistic more likely belongs. The statistic is assumed to be an instance of the distribution's random variable. The figure illustrates a correlation hypothesis test. The probability density function to the left encompasses the values of the random variable that indicate that the two contact reports/tracks do not represent the same target. The probability density function to the right encompass the values of the random variable that indicate that the two contact reports/tracks do represent the same target. The figure places the threshold at a typical location. If the value of the statistic falls to the left, correlation is rejected; if the value falls to the right, correlation is accepted. The area under a function's curve within the "territory" of the other function equals the Type I or Type II error probability.

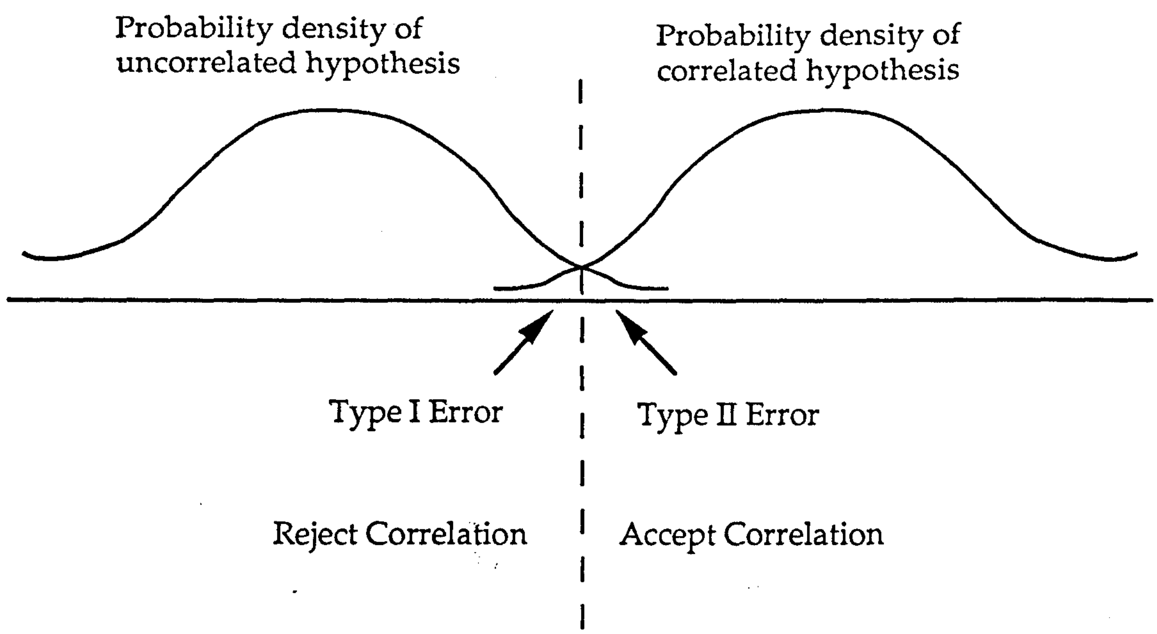

Figure 3.2.1.1 - 1 - Correlation Performance

Error probabilities can be monitored by maintaining four counters:

- CA - Number of correct correlations
- IR - Number of incorrectly rejected correlations
- IA - Number of incorrect correlations
- CR - Number of correct non-correlations

CA and IA are based on a count of (1) correlation alerts or (2) reaffirmation of the correlation condition for an updated component of a fused track.

IR and CR are based a count of internal (individual) non-correlations following track updates or additions.

Errors are expressed as follows:

$$\text{Type I Error} = \frac{IR}{CA + IR} \qquad \text{Type II Error} = \frac{IA}{CR + IA}$$

Note that in practice the intervention of the operator can be expected to improve

performance with respect to Type I and Type II errors.

3.2.1.1.1 Correct, Missed, and False Correlations, and Correct/Not Correlated Statistics

The testbed extraction file has three records which determine that a MSC decision for correlation or decorrelation has taken place. GEOSCOREU records are generated from correlation tests of updated unfused objects when they are compared to each candidate in the data base. FUSEALERT records are generated along with the CORRELATION ALERT. These two results are similar, but FUSEALERT applies to only the best of the alertable correlation tests whereas GEOSCOREU applies to all the tests of an updated object against the objects in the data base. GEOSCOREC records are generated when a component of a fused object is updated. In all cases, the correlation decision is compared with the true target identification information to determine and accumulate results. The true target position and velocity information comes from the ATSG extraction file, TRUEPOS record. The true target identification for unfused objects comes from the ATSG extraction file, TRKADDUPD record. A connecting link from fused to unfused object components is provided by the testbed extraction file, FUSTRKNEW and FUSTRKADD records.

3.2.1.1.1.1 Correct Correlations
A Correct Correlation is counted whenever a correct positive correlation decision is produced between two objects from a FUSEALERT or GEOSCOREC record.

3.2.1.1.1.2 Missed Correlations (Type I Errors)
Missed Correlations are counted for each applicable component whenever an incorrect negative correlation decision is produced between two objects from a GEOSCOREU or GEOSCOREC record. In the case of a fused object, an incorrect negative correlation counts a Missed Correlation for each component of the fused track truly associated with the updated track. Missed correlations are counted and stored by component pair (fused component plus updated object being negatively correlated) , rather then by negative correlation decision. This is necessary to reasonably account for recovery of a missed correlation of an updated fused object. The object essentially disappears when decorrelated by the negative correlation decision based on the GEOSCOREC record. This disappearance would prevent tracking of recovery statistics which is described in the following paragraphs.

3.2.1.1.1.3 False Correlations (Type II Errors)
False Correlations are counted whenever an incorrect positive correlation decision is produced between two objects from a FUSEALERT or GEOSCOREC record. Unlike Missed_Correlations, False_Correlations are NOT counted by component but by the number of incorrect positive correlation decisions.

3.2.1.1.1.4 Correct Non_Correlations
Correct Non_Correlations are counted whenever a correct negative correlation decision is produced between two objects from a GEOSCOREU or GEOSCOREC record in the testbed extraction file.

3.2.1.2 Type I Error and Type II Error Recovery
The analysis generates statistics on the duration of an error sequence preceding recovery from that error condition, i.e, the duration of the error situation. This is referred to as error recovery. In general, recoveries of Missed Correlations (Type I error) and False Correlations (Type II error) are counted whenever the erroneous situation is corrected.

3.2.1.2.1 Type I Error Recovery
Type I Error Recovery is the span in track updates from the time two different sensor tracks from the same target failed to correlate to the time they correlated. This is expressed as the total number of these updates in the case, the number of associated recoveries and their quotient. The number of Type I errors is also provided.

A Missed Correlation (Type I error) is recovered by a Correct_Correlation with corresponding objects. Since the statistics for Missed Correlations are maintained by fused component, a Correct Correlation between a fused object and an unfused object must cause a check of each component of the fused object for possible recovery with respect to the unfused object. Both Missed Correlations and their recoveries are counted by component. In addition to counting recoveries, the number of consecutive missed correlations prior to the recovery is also counted and accumulated. The accumulated number of consecutive missed correlations prior to recovery divided by the number of recoveries gives an indication of how long a missed correlation lasts. This average is provided in the report for each case.

The number of Unrecovered Missed Correlations is the difference between the total number of Missed Correlations and the accumulated number of consecutive recovered Missed Correlations.

3.2.1.2.2 Type II Error Recovery

Type II Error Recovery is the average span in track updates from the time that sensor tracks from different targets correlated to the time the errant fused track decorrelated. In the case where fused tracks are not accepted, the recovery takes place either when the same pair of components fail to correlate or when one of the components correlates with a different track which is the span in track updates from the time that the sensor tracks from different targets correlated to the time the errant fused track decorrelated. In the case where fused tracks are not accepted, the recovery takes place either when the same pair of fused components fails to correlate or when one of the components correlates with a different track which is incompatible with the original correlation. The incompatibility is bases on the two tracks being based on their same sensor. This is expressed as the total number of these updates in the case, the number of associated recoveries and their quotient. The number of Type II errors is also provided.

False Correlations (Type II errors) can be recovered in two ways. A Correct Non_Correlation for an equivalent pair of objects will recover the false correlation regardless of whether the objects were fused or not. A Correct Correlation also can recover an unaccepted False Correlation if a sensor of a component of the Correct Correlation is the same as a sensor of one of the two objects associated with the previous unaccepted and unrecovered false correlation. In either case, the recoveries are counted along with the number of consecutive false correlations prior to the recovery. The accumulated number of consecutive false correlations prior to recovery divided by the number of recoveries gives an indication of how long a false correlation lasts. This average is provided in the report for each case.

3.2.2 Fused Accuracy Analysis

This analysis provides statistics on the accuracy performance of fused tracks versus its components. The requirement that the fused track accuracy be as good or better than the best of its components is being tested here. Since acceptance of the correlation alert is required for the fused track to be generated, the policy for alert

response is "Accept all" for this analysis. It should be noted however, that alerts for additions to the data base are always rejected to prevent object ID conflict. As discussed in section 1.5.2, this is a testbed environment constraint which we deal with by putting all additions to the data base up front before any object updates. All updates to the data base generating an alert are accepted for Fused Accuracy Analysis.

3.2.2.1 Position and Velocity Magnitude Error

These errors were computed and recorded for both sensor tracks and fused tracks. Fused track errors were compared to the errors from the sensor tracks. The average of a specific track's errors represented the performance measure.

Calculations for these errors are:

$$\text{Position Error} = \text{sqrt}[\,(\text{Xest}-\text{Xtrue})^2 + (\text{Yest}-\text{Ytrue})^2\,]$$

$$\text{Velocity Error} = \text{sqrt}[\,(\text{VXest}-\text{VXtrue})^2 + (\text{VYest}-\text{VYtrue})^2\,]$$

where:
Xest , Yest are the components of estimated position
Xtrue, Ytrue are the components of true position
VXest, VYest are the components of estimated velocity
VXtrue, VYtrue are the components of true velocity

3.2.2.2 Mean Radial Circular Uncertainty

Mean Radial Circular Uncertainty (MRCU) was calculated from elements of a fused track covariance matrix as follows:

$$\text{MRCU} = \text{sqrt}[\text{var}(x) + \text{var}(y)]$$

MRCU is a representation of the tracking algorithm's computed area of uncertainty (AOU), and the AOU is used by the operator to gauge the accuracy of tracking information. How well this statistic compares with the actual position error quantifies the reliability of the tracking algorithm's uncertainty estimates.

If the position errors are Gaussian distributed and the AOU is circular, then the

probability that the position error is less than k*MRCU is:

$$p = 1 - \exp(-(k^2)/2)$$

A circular region of radius 1*MRCU is the approximate .4 probability region. Regions of radius 1.1774*MRCU and 2.448*MRCU are the approximate .5 and .95 probability regions respectively. The "approximate" qualifier is added because the AOU is typically elliptical rather than circular.

The proportion of position estimates for a given track falling within these circular regions was compared to the associated probability.

3.2.2.3 Normalized Error

The Normalized Error (NE)was calculated as follows:

$$NE = (Xest\text{-}Xtrue)^T P^{-1} (Xest\text{-}Xtrue)$$

where X is the 2-dimension position estimate and P is the associated 2x2 covariance matrix. It is a more generalized indicator of error performance than true error statistics. Whereas true error statistics must be qualified by the specific scenario under which they were computed, the inverse covariance matrix term in the normalized error statistic compensates for a scenario's aircraft/target dynamics.

The distribution of normalized error statistics for a given track should be that of a chi-square random variable with two degrees of freedom, whose accumulated distribution is 10% at X=.21 and whose accumulated distribution is 90% at X=6.41. X is the density function's independent variable. How well the set of normalized error statistics conforms to the chi-square distribution is a criteria for evaluating the quality of the tracking algorithm.

3.3 Test Case Description

This section documents the tests performed to validate the Multi-Sensor Correlation portion of the Navy P-3 UPDATE IV software. Tests were accomplished using the UPDATE IV Testbed developed by Boeing Aircraft Co. and the Automatic Test Scenario Generator (ATSG) developed at NAWC, Aircraft Division, Warminster.

The test cases were divided into test categories which were designed to test performance according to the performance groups described above. The correlation performance group uses a few test categories. In Tables 3.3.1 - 1 through 3.3.5 - 3, "Target Motion" describes motion both with respect to each other and with respect to the aircraft racetrack pattern; so parallel/perpendicular" denotes parallel motion targets on a course perpendicular to the aircraft pattern. "Initial Target Range" is the initial range from the aircraft pattern to the closest target. Plots representing the target motion for the various scenarios are shown in section 4.2.2.1.

3.3.1 Test Category 1

Basic correlation performance was tested in this category. Position and velocity error were also tested. The test cases are described in Tables 3.3.1 - 1 through 3.3.1 - 4 below.

TEST CASE	1	2	3	4
Simulation Duration	30 mins	30 mins	30 mins	30 mins
A/C Speed	200 Knts	188 Knts	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track	Race Track	Race Track
A/C Radius	2 NM	2 NM	5 NM	2 NM
Number of Targets	2	2	2	2
Aircraft Altitude	500 ft	500 ft	500 ft	500 ft
Sensor(s)	Radar & Visual	Radar & Visual	Radar & Visual	Radar & Visual
Target Classification	Surface	Surface	Surface	Surface
Targets Motion	Para/Para	Para/Para	Para/Para	Para/Para
Initial Target Range	50NM	50NM	50NM	10NM
Target Separation	1 NM	5 NM	1000 ft	1000 ft
Target N Offset	8 NM	8 NM	8 NM	8 NM
Target Speed	10 Knts	10 Knts	10 Knts	10 Knts

Table 3.3.1 - 1 - Test Category 1

TEST CASE	5	6.	7	8
Simulation Duration	30 mins	30 mins	30 mins	30 mins
A/C Speed	200 Knts	200 Knts	200 Knts	200 Knts
A/C Pattern	Race Track	Race Track	Race Track	Race Track
A/C Radius	2 NM	2 NM	2 NM	2 NM
Number of Targets	2	2	2	2
Aircraft Altitude	500 ft	500 ft	500 ft	500 ft
Sensor(s)	Radar & Visual	Radar & Visual	Radar & Visual	Radar & Visual & MAD
Target Classification	Surface	Surface	Surface	Surface
Targets Motion	Para/Para	Para/Para	Para/Para	Para/Para
Initial Target Range	100NM	100NM	50NM	50NM
Target Separation	1 NM	1000 ft	1000 ft	1000 ft
Target N Offset	8 NM	8 NM	8 NM	8 NM
Target Speed	10 Knts	10 Knts	10 Knts	10 Knts

Table 3.3.1 - 2 - Test Category 1 cont.

TEST CASE	9	10	11	12
Simulation Duration	30 mins	30 mins	30 mins	30 mins
A/C Speed	188 Knts	188 Knts	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track	Race Track	Race Track
A/C Radius	2 NM	2 NM	5 NM	2 NM
Number of Targets	2	2	2	2
Aircraft Altitude	500 ft	500 ft	500 ft	500 ft
Sensor(s)	Radar & Visual	Radar & Visual	Radar & Visual	Radar & Visual
Target Classification	Surface	Surface	Surface	Surface
Targets Motion	Para/Perp	Para/Perp	Para/Para	Para/Para
Initial Target Range	50 NM	50 NM	50NM	50NM
Target Separation	1250 ft	750 ft	1000 ft	1000 ft
Target N Offset	10 NM	10 NM	8 NM	8 NM
Target Speed	20 Knts	20 Knts	10 Knts	10 Knts

Table 3.3.1 - 3 - Test Category 1 cont.

TEST CASE	27	28
Simulation Duration	30 mins	30 mins
A/C Speed	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track
A/C Radius	2 NM	2 NM
Number of Targets	2	2
Aircraft Altitude	500 ft	500 ft
Sensor(s)	Radar & Visual	Radar & Visual
Target Classification	Surface	Surface
Targets Motion	Para/Perp	Para/Perp
Initial Target Range	50 NM	50 NM
Target Separation	1250 ft	750 ft
Target N Offset	8 NM	8 NM
Target Speed	10 Knts	10 Knts

Table 3.3.1 - 4 - Test Category 1 cont.

3.3.2 Test Category 2

Air target correlation performance was tested in this category. Position and velocity error were also tested. The test cases are described in Table 3.3.2 - 1 below.

TEST CASE	1	2
Simulation Duration	30 mins	30 mins
A/C Speed	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track
A/C Radius	5 NM	5 NM
Number of Targets	2	2
Aircraft Altitude	2000 ft	2000 ft
Sensor(s)	Radar & Visual	Radar & Visual
Target Classification	Air (1000 ft alt)	Air (1000 ft alt)
Targets Motion	para/perp	para/para
Initial Target Range	50 NM	50 NM
Target Separation	1 NM	1 NM
Target N Offset	8 NM	8 NM
Target Speed	300 Knts	300 Knts

Table 3.3.2 - 1 - Test Category 2

3.3.3 Test Category 3

Target movement correlation performance was tested in this category. Position and velocity error were also tested. The test cases are described in Table 3.3.3 - 1 below.

TEST CASE	1	2	3	4
Simulation Duration	30 mins	30 mins	30 mins	30 mins
A/C Speed	200 Knts	200 Knts	200 Knts	200 Knts
A/C Pattern	Race Track	Race Track	Race Track	Race Track
A/C Radius	5 NM	5 NM	5 NM	5 NM
Number of Targets	2	2	2	2
Aircraft Altitude	500 ft	500 ft	500 ft	500 ft
Sensor(s)	Radar & Visual	Radar MAD & Visual	Radar & MAD & Visual	Radar & MAD & Visual
Target Classification	Surface	Surface	Surface	Surface
Targets Motion	Cross-Over	Cross-Over	Cross-Over	Cross-Over
Initial Target Range	50 NM	50 NM	50 NM	50 NM
Target Separation	1 NM	5 NM	1 NM	5 NM
Target N Offset	8 NM	8 NM	8 NM	8 NM
Target Speed	20 Knts*	20 Knts*	20 Knts***	20 Knts***

* - Decelerate at 10 Knts/hr; 15 minutes later Accelerate at 10 Knts/hr

Table 3.3.3 - 1 - Test Category 3

3.3.4 Test Category 4

Type I Error recovery was tested in this category. The test cases are described in Table 3.3.4 - 1 and 3.3.4 - 2 below.

TEST CASE	1	2	3	4
Simulation Duration	30 mins	30 mins	30 mins	30 mins
A/C Speed	188 Knts	188 Knts	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track	Race Track	Race Track
A/C Radius	5 NM	5 NM	5 NM	5 NM
Number of Targets	1	1	1	1
Aircraft Altitude	500 ft	500 ft	500 ft	500 ft
Sensor(s)	Radar & Visual	Radar & MAD & Visual	Radar & Visual	Radar & MAD & Visual
Target Classification	Surface	Surface	Surface	Surface
Targets Motion	Direct to S	Direct to S	Direct to E	Direct to E
Initial Target Range	50 NM	50 NM	50 NM	50 NM
Target Separation	N/A	N/A	N/A	N/A
Target N Offset	10 NM	10 NM	10 NM	10 NM
Target Speed	10 Knts	10 Knts	10 Knts	10 Knts

Table 3.3.4 - 1 - Test Category 4

TEST CASE	10	11	12
Simulation Duration	188 secs	188 secs	188 secs
A/C Speed	188 Knts	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track	Race Track
A/C Radius	5 NM	5 NM	5 NM
Number of Targets	1	1	1
Aircraft Altitude	500 ft	500 ft	500 ft
Sensor(s)	Radar & MAD & Visual	Radar & MAD Visual	Radar & MAD & Visual
Target Classification	Surface	Surface	Surface
Targets Motion	Direct to S	Direct to S	Direct to S
Initial Target Range	50 NM	50 NM	50 NM
Target Separation	N/A	N/A	N/A
Target N Offset	0 NM	0 NM	0 NM
Target Speed	10 Knts	10 Knts	10 Knts

Table 3.3.4 - 2 - Test Category 4 cont.

3.3.5 Test Category 5

Type II Error recovery was tested in this category. The test cases are described in Table 3.3.5 - 1 below.

TEST CASE	1	2	3
Simulation Duration	30 mins	30 mins	30 mins
A/C Speed	188 Knts	188 Knts	188 Knts
A/C Pattern	Race Track	Race Track	Race Track
A/C Radius	2 NM	2 NM	2 NM
Number of Targets	3	3	3
Aircraft Altitude	500 ft	500 ft	500 ft
Sensor(s)	MAD (1) & Radar (2) & Visual (3)	MAD (1) & Radar (2) & Visual (3)	MAD (1) & Radar (2) & Visual (3)
Target Classification	Surface	Surface	Surface
Targets Motion	| | to East*	| | to East*	| | to East*
Initial Target Range	100 ft w/in a/c pattern*	0.5 NM w/in a/c pattern*	500 ft
Target Separation	200 ft	1 NM	1 NM
Target N Offset	8 NM	18 NM	18 NM
Target Speed	10 Knts	10 Knts	10 Knts

Table 3.3.5 - 1 - Test Category 5

* - Refer to Figure 3.3.5 - 1 for pictorial representation of Initial Target Range on the following page.

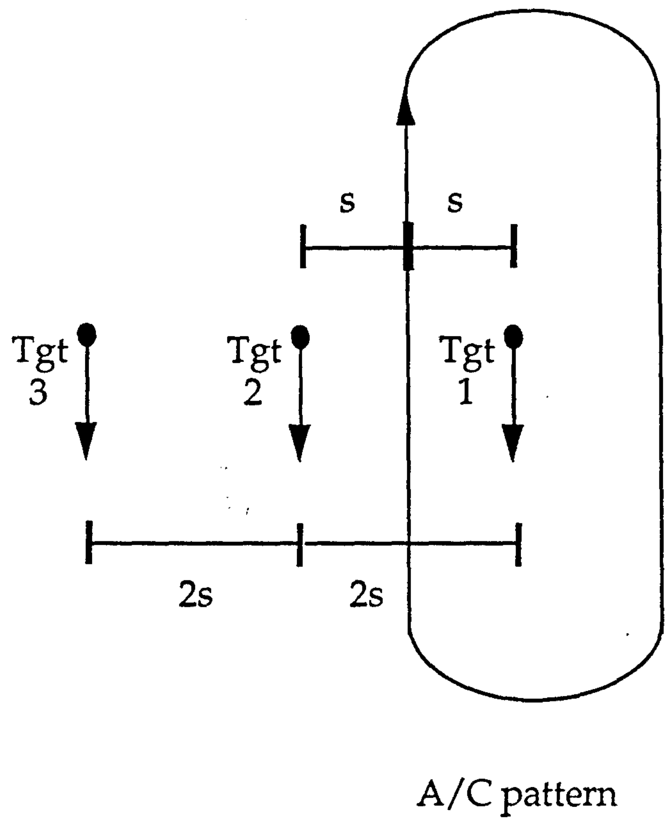

Figure 3.3.5 - 1 - Pictorial description of Initial Target Range for Cases 1 and 2

4.0 TEST PROCEDURES

4.1 PreTest Preparation

Several actions needed to be taken prior to testing Multi-Sensor Correlation including:

- Data Extraction Preparation
- Operational Code Modification
- Supplementary Software Generation

4.1.1 Data Extraction

To test the algorithms of each performance group, data was extracted from the software during each addition and update of a fused track or its components. Truth data and raw track data were also extracted for comparison purposes. Extractions for all iterations representing a test case were captured in the "msc_atsg.accum" file for ATSG extractions and "msc_model.accum" file for Testbed extractions. The "msc_atsg.accum" file accumulates all the data in a multiple scenario file build; the "msc_model.accum" file accumulates all the data in a multiple Testbed run. The file "msc_atsg.accum" contains true target states, sensor track state estimates and covariance matrices, and mapping between targets and sensor tracks. The file "msc_model.accum" contains results of correlation/decorrelation tests, fused track state estimates and covariance matrices, and mapping between sensor tracks and fused tracks. The following paragraphs describe what data was extracted and how it was extracted.

4.1.1.1 Data to be Extracted for Algorithm Evaluation

The following data was extracted from ATSG and Testbed runs to support the MSC analyses:

- Target ID's of input and output tracks
- Object ID's of input and output tracks in track-to-track fusion function
- Target track position
- Target track velocity
- Target track covariance matrix
- True target position
- True target velocity
- Time of the track entry/update in the data base
- An indication of the condition of fusability/correlation (true/false)

4.1.1.2 Code Modifications for Data Extraction

Data was extracted into files, one by the ATSG and one by the Testbed. In both cases, files are in ASCII and each line begins with a keyword which is used as an identifier for the analysis program. Keywords are indicated in parentheses below as (KEYWORD).

The data extracted from the ATSG was as follows:

- True data (TRUEPOS) was extracted including the time, Target ID, state (position and velocity), and covariance matrix.

- Track data (TRKADDUPD) is extracted including time, sensor, Target ID, object ID, state (position and velocity), and covariance matrix.

The data extracted from the testbed came from 2 testbed routines as follows:

- crcrtfac_automatic_correlation_body.a
  This file contains routines for checking unfused track objects for possible correlation with other objects in the database. Whenever an unfused object/track was updated, an indication of the fusability/correlation with other objects was extracted (GEOSCOREU). Whenever the best of these objects is selected for a correlation alert, a similar extraction is produced called FUSALERT Whenever a track was correlated and fused into another object, the event was extracted (FUSFIXNEW or FUSFIXADD) including the state (position and velocity) and covariance matrix. The FUSFIXADD record was used for adding another component to a previously fused object with other components.

- crcrduup_update_fused_track_body.a

  This file contains routines for checking fused tracks for ongoing fusability of its components and updating these components based on new measurements. Whenever a component of a fused track was updated, an indication of the fusability/correlation was extracted (GEOSCOREC). If they remained correlated, the fused track/object was updated and the data was extracted (FUSFIXUPD) including the state (position and velocity) and covariance matrix.

4.1.2 Operational Code Modifications

In normal MSC operations the user must respond to correlation and split track alerts. To eliminate the need for user interaction, the Mission Software was modified to permit either automatic rejection or automatic acceptance of all alerts. When starting up an individual run, the command rtb included a prompt to select either no automatic answering, automatic acceptance, or automatic rejection. If another method was used, the parameter Running_Testbed needed to be set to the true condition in the file generic_input_parameters. Also, the parameters auto_answer_add_mode and auto_answer_update_mode were set in the file generic_input_parameters to determine the alert response mode desired. The three possible modes included 1.) accept all, 2.) reject all or 3.) no automatic answer. Automatic accceptance and automatic rejection were both selected for each case. However, tests of interest and their associated options are listed in Figure 4.1.2 - 1.

TEST TYPE	ACCEPT or REJECT
Correlation Performance	Reject All
Type I Correlation Error Recovery	Reject All
Type I Correlation Error Recovery	Reject All
Root Mean Square Error	Accept All
Mean Radial Circular Uncertainty	Accept All
Normalized Error	Accept All

Figure 4.1.2 - 1 - Automatic Alert Answering Options

It should be noted that "reject" was always the response during track additions as stated in Section 1.5.2 of this document.

4.1.3 Supplementary Software Development

Several routines and command files were essential to evaluate Multi-Sensor Correlation algorithm performance.

4.1.3.1 Testbed Scenario Generation

Since scenarios needed to be developed in a timely fashion, a system which automatically generated scenarios, called Automatic Testbed Scenario Generation (ATSG), was developed. A method was also needed to generate multiple scenarios. The scenario generation process is described in the following sections.

4.1.3.1.1 ATSG Description

To test MSC algorithms, several test scenarios were required. The testbed requires these scenarios to be in the form of compilable ADA package files containing declarations for items to be put into the data base and special comment lines which are preprocessed for use by the testbed. However, generating a scenario file manually is extremely time consuming. The ATSG program was developed to ease their production.

The ATSG takes user descriptions of aircraft and target scenarios and outputs an Ada formatted file of data records called the scenario file. The ATSG requires four input files to create the test scenario. They are the Platform Movement Input File (platform_data.dat), the Emitter Data Input File (emitter_data.dat), the Event Data Input File (event_data.dat) and the Testbed Code Parameters Input File (generic_input_parameters).

The platform_data.dat file specifies aircraft and target motions. It, also, specifies the multiplying factor to apply to random errors. Target emitter characteristics are specified by the emitter_data.dat file. The event_data.dat file contains simulated detections in terms of time, sensor and target. The generic_input_parameters file contains information relating to plots and methods for running the testbed. For example, it specifies the initial velocity standard deviation for sensor tracking. The input format of the file was designed for adaptability to a highly versatile user containing the following features:

1. Readability.
    - Each line contains a label and a data element.
    - Blank lines are permitted.
2. The order of the data lines is inconsequential.
3. Modifications to the data file and/or the user program can be easily made both upward and downward compatible.

For a further description of the ATSG, refer to Automatic Testbed Scenario Generation Users' Manual and Section 4.2.2 of this document.

The scenario file produced by the ATSG contains the data needed by the MSC algorithms; the data includes aircraft position updates, perturbed sensor measurements and sensor tracker updates. The ATSG computes perturbed sensor measurements using true aircraft/target positions and the software system's random number generator. Because the goal of the ATSG was to test the MSC algorithms and not necessarily the sensor trackers, the two step process of passing measurement data to a sensor tracker and then passing both measurement data and sensor tracker output to the MSC algorithms was simplified to a one step process by incorporating the sensor trackers from the operational program directly into the ATSG. Sensor tracker processing is ,therefore, performed within the ATSG, and tracker outputs are packaged in the scenario file along with sensor measurements and aircraft positions. However, the performance of the sensor tracker was found to be defective in one simple way. The initial velocity variance was both unreasonably small and independent of platform. The Update IV operational code provided a constant of 7 Knots for the velocity standard deviation which caused a very slow convergence for fast moving targets. This was modified to allow user entry of the initial standard deviation via the generic_input_parameters file for each platform type. Values used corresponded to the actual target speed.

The scenario file produced by the ATSG is an Ada source file with an extension of ".a". Before it can be used by the Testbed, it must be compiled and then processed by a utility called the Preprocessor. The Preprocessor generates a companion file needed by the Testbed. This companion file has the same name as the scenario file but has an extension of ".cmd" instead of ".a".

4.1.3.1.2 ATSG Multiple Runs

In order to gather the amount of data needed to discover statistical trends, a given scenario must be run multiple times with a different random number generator seed each time. The command "atsg_runs.com" used a set of ATSG input files to generate a scenario set. The command file, also, compiled and preprocessed the set and activated the data extraction accumulation. So that no filename conflicts would occur, a unique file naming scheme was used. Scenario files were named sf###.a

where ### is a number which was incremented by one with each scenario in a set. The command file automated the process of managing the random number generator by using the scenario number as the random number seed. This not only provided automation but also reproducibility. To exactly reproduce a scenario , the ATSG input data files and the random number seed would have to be duplicated. Data extraction accumulation files were named msc_atsg.accum%## where, % was the number of the Test Category and ## was the Test Case. Refer to Section 3.3 of this document for description of Test Category and Test Case. Refer to Section 4.2.4 of this document for details regarding the atsg_runs.com file.

4.1.3.2 Testbed

4.1.3.2.1 Testbed Description

The Testbed can be defined as the collection of modules that contain the operational program's mission functions, the operational program's executive system, the operator station simulator, and the handler of the simulated tactical scenarios. The collection consists of:

- Mission Software
- System Management Software/System Operations Software (SMS/SOS)
- SUNVIEW graphical user interface
- Programmable Entry Panel (PEP) driver
- Color High Resolution Display (CHRD) driver
- I/O driver
- Events driver

Elements of the SMS/SOS are:

- Operating system
- Database management
- Display management
- Alphanumeric display management
- Data entry
- Display generation management.

A Testbed Build is a recompilation of this software suite. A Build is needed when the software is enhanced and/or modified to accommodate a specific experiment. Inclusion of data extraction code is a usual modification.

The Update IV operational program was designed around Ada's tasking feature, and this enabled its seamless integration into the laboratory. In a task/event driven software environment, all major activity such as I/O is queued and presented to a task/event monitor under a consistent protocol. The task/event monitor handles all dispatching chores. Therefore, simulating a tactical environment is accomplished by constructing a data file that the event driver can format and schedule as tasks. Manually constructing a reasonably sized data file would be tedious, so the ATSG was developed to automate the process.

4.1.3.2.2 Testbed Multiple Runs

Each scenario set was run on the Testbed. Again, manually running each scenario in a set was time consuming. Therefore, a multiple run command file was generated. It is presented in Appendix E.

The Testbed also restricted the number of scenario schedule lines it allowed to 450. This was not sufficient for our needs, so the Update IV operational program used to run a testbed scenario was copied and changed to handle 1450 schedule lines.

4.1.3.3 Analysis

Analysis code was developed to analyze Type I and Type II Errors and to analyze Fused Accuracy. The command file anal.com was also prepared to perform all analyses automatically with the predefined options. More analysis information can be found about analysis in Section 4.2.6.

4.2 Test Preparation and Execution

4.2.1 Overview

Testing was done using the UPDATE IV Testbed developed by Boeing Aircraft Co.; the Automatic Test Scenario Generator (ATSG) and multiple scenario, multiple run, and analysis tools developed at NAWCADWAR. Six steps were required to test and analyze the Multi-Sensor Correlation portion of the P-3 Update IV software. The steps are as follows:

- Design a scenario file.
- Prepare data input files.

- Generate a scenario file.
- Compile multiple iterations of the scenario file.
- Run the testbed for each iteration.
- Analyze the data.

These steps were followed for each test case described in Section 3.3. They are briefly described in the following sections. Data analysis and results are further described in Section 5.0.

4.2.2 Prepare Data Input Files

Input files are required for both ATSG and for the Testbed.

4.2.2.1 ATSG Input Files

Reference the Automatic Testbed Scenario Generation (ATSG) Users' Manual for detailed information about creating and using ATSG input data files. The input data files we used were as follows:

- emitter_data.dat - This file contains three emitters, where one , two or three emitters were used for a particular scenario. Each target was identical in type, class and platform.

- generic_input_parameters - This file is copied into the generic_input_parameters file described in the ATSG Users' Manual.

- event_data.dat - Different files were needed depending upon the test case. So, six generic files were created and copied for the various cases into event_data.dat used to generate the scenario file. Each event generic produces a test case of thirty minutes. The six generics include:
    1.) One target with sensors,
    2.) One target with three sensors,
    3.) Two targets with two sensors each,
    4.) Two target with three sensors each,
    5.) Three targets with three sensors each and
    6.) Three targets with one different sensor a piece.

A copy of each generic can be found in Appendix C of this document.

• platform_data.dat - Again, different files were required for each test case. However, more than six were required. So, a set of seven template files and a command file to create and copy a platform_data.dat file were used. A copy of each generic can be found in Appendix D of this document. This is described more in Section 4.2.3.2. The template files include the following:

1.) Aircraft in racetrack pattern. One target moving parallel to the aircraft. See Figure 4.2.2.1-1.

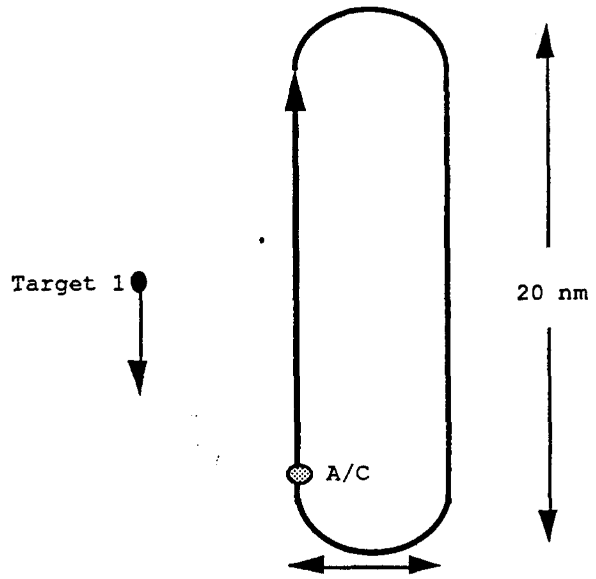

Figure 4.2.2.1 - 1 - Platform Movement Example 1

2.) Aircraft in racetrack pattern. One target moving away from the aircraft. See Figure 4.2.2.1-2.

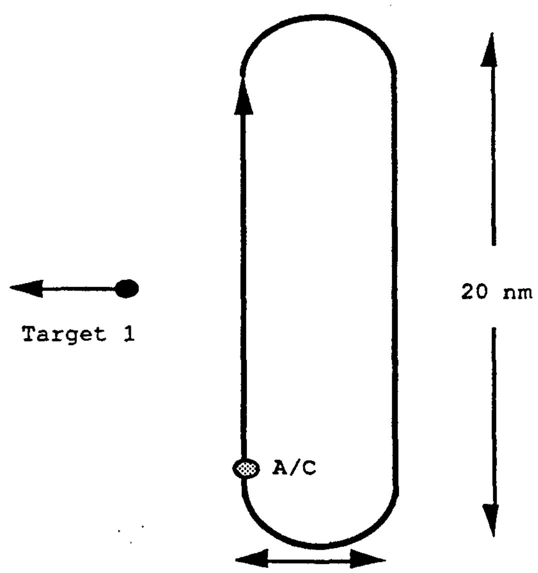

Figure 4.2.2.1 - 2 - Platform Movement Example 2

3.) Aircraft in racetrack pattern. Two targets moving parallel to the aircraft. See Figure 4.2.2.1-3.

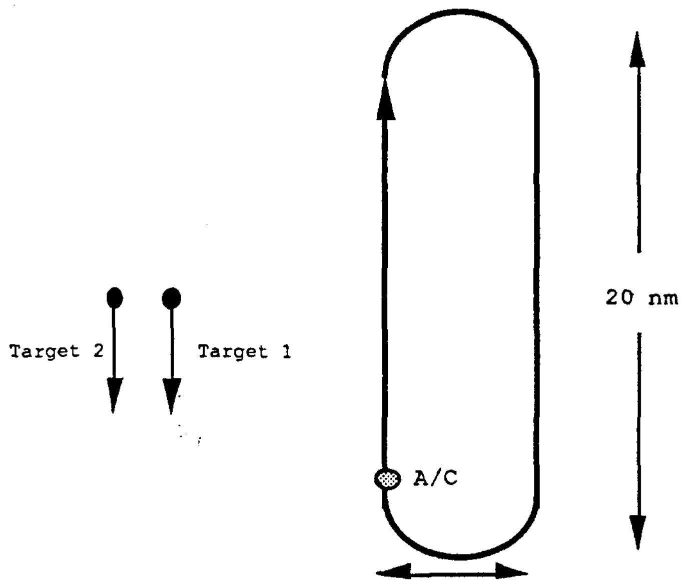

Figure 4.2.2.1 - 3 - Platform Movement Example 3

4.) Aircraft in racetrack pattern. Two targets moving away from the aircraft. See Figure 4.2.2.1-4.

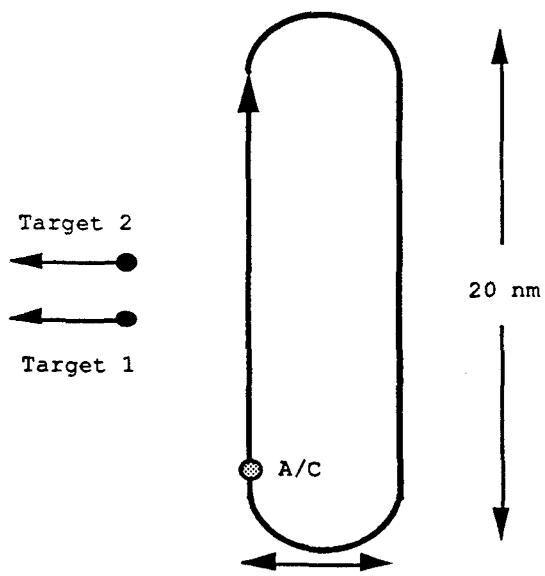

Figure 4.2.2.1 - 4 - Platform Movement Example 4

5.) Aircraft in racetrack pattern. Two targets crisscrossing and moving away from the aircraft (with or without acceleration/deceleration). See Figure 4.2.2.1-5.

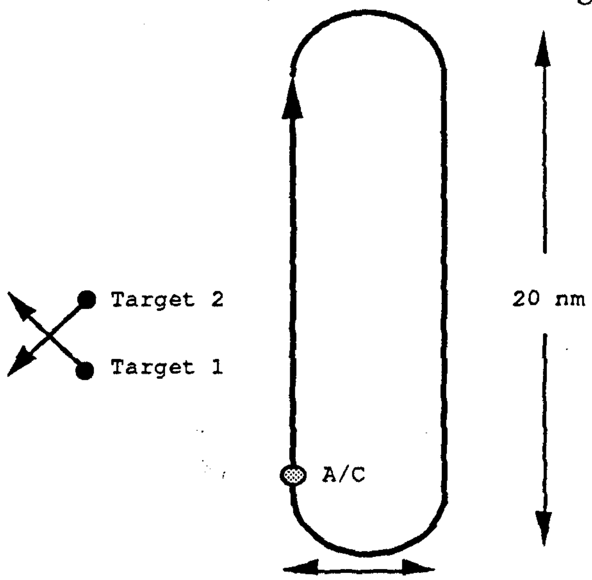

Figure 4.2.2.1 - 5 - Platform Movement Example 5

6.) Aircraft in racetrack pattern. Two decelerating/accelerating targets criss-crossing and moving away from the aircraft. The diagram is identical to Figure 4.2.2.1 - 5.

7.) Aircraft in racetrack pattern. Three targets moving parallel to the aircraft. See Figure 4.2.2.1 - 6.

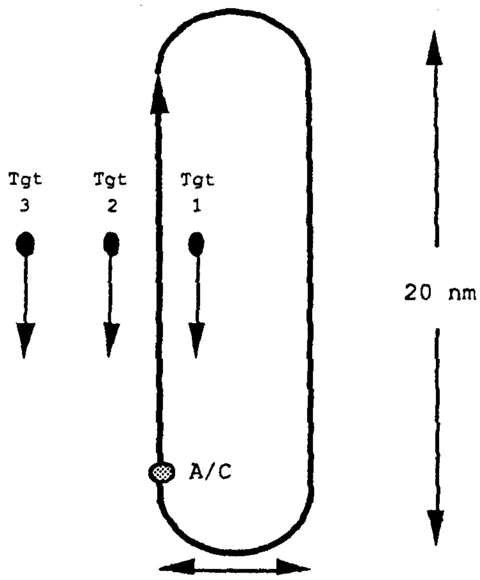

Figure 4.2.2.1 - 6 - Platform Movement Example 6

4.2.2.2 Testbed Input Files

Two input files were required for the Testbed .1) generic_input_parameters_accept_all and 2.) generic_input_parameters_reject_all. Each contained three parameters as follows:

- Running_Testbed - This parameter determined if the testbed is running. It was always set to 1 for true.

- Auto_Answer_Add_Mode - This parameter was required to be -1 for "reject all" when a track was added to the database. A value of 1 would cause acceptance of database additions which would risk object ID errors.

- Auto_Answer_Update_Mode - This parameter determined whether a correlation alert and split track alert was accepted, rejected or not answered during all track updates. The parameter data varied in each input file as follows:
  - generic_input_parameters_accept_all - 1
  - generic_input_parameters_reject_all - 2

4.2.3 Generate a Scenario File

A scenario file was generated, the compilation performed and the preprocessing completed multiple times in one step using the command file atsg_runs.com. It is described in the next section.

4.2.4 Compile Multiple Iterations of the Scenario File

Using the command file atsg_runs.com, we were able to generate, compile and preprocess multiple scenario files each identical except for the random seed used to vary the perturbation of positions sent to the sensor tracking algorithms.

4.2.4.1 Preparation of the Command File

Key lines of the atsg_runs.com are listed below with a number on the left hand side referencing the subsection below that describes it. A copy of an example atsg_runs.com is in Appendix B.

```
# P8: The full path to the directory where the ATSG data
#     files reside and the scenario files will be produced.
1 setenv ATSGDATA ~uiv/production/atsg

# P9: The full paths to the directory where the ATSG executable resides.
2 setenv ATSGEXEC ~uiv/production/atsg

# P10: The full path to the directory where the testbed is run
3 setenv TESTBED ~uiv/production/testbed

# The variable below is the full path to the ATSG execution script file.
4a setenv ATSGRUN   ~uiv/tools/atsg_run.com

5a goto case_num
-----------------------------------------------------------------
echo "1. MultiSensor Correlation Test Category 1 - Test Case 4"
# Call the command file to update the necessary input file(s)
pmm_edit.com platform_para_para.dat400 -500.0 0.133091 -0.166376 10.0 0.133091 -0.169115 10.0
cp ~uiv/production/atsg/event_data_2tgts_2sens.dat event_data.dat0 event_data.dat

# Go to start and do 50 iterations of the test case
goto start
-----------------------------------------------------------------
5b case_num:
echo "1. MultiSensor Correlation Test Category 1 - Test Case 2"
# Call the command file to update the necessary input file(s)
6 pmm_edit.com platform_para_perp.dat400 -500.0 0.166376 -0.831882 10.0 0.168430 -0.831832 10.0
7 cp ~uiv/production/atsg/event_data_2tgts_2sens.dat      event_data.dat

# Go to start and do multiple iterations of the test case
goto start
start:
  echo "Starting iteration $count of $MAXITER with scenario file sf$sf_num.a"
 4b $ATSGRUN 0 0 0 0 $sf_num $PLOT $COMPILE $ATSGDATA $ATSGEXEC $TESTBED
```

Figure 4.2.4.1 - 1 - Example of atsg_runs.com

4.2.4.1.1 ATSG Data

The Unix environment parameter ATSGDATA (in line 1 of Figure 4.2.4.1 - 1) indicated the directory where the ATSG input data files were located.

4.2.4.1.2 ATSG Executable

The Unix environment parameter ATSGEXEC (in line 2) indicated the directory where the ATSG execution takes place.

4.2.4.1.3 Scenario Location

The Unix environment parameter TESTBED (in line 3) indicated the directory where the scenario files were placed for compilation, preprocessing and use by the testbed. This directory required only the testbed library. See Section 3.1 for more information

4.2.4.1.4 Compilation and Preprocessing

The Unix environment parameter ATSGRUN (in line 4a) indicated the directory where the ATSG compilation command file was located. Line 4b calls the command file with the required parameters. A copy of an example atsg_run.com file can be found in Appendix B.

4.2.4.1.5 Test Case Selection

Since multiple test cases were located in the atsg_runs.com file and only one could be compiled at a time, goto labels were needed to select the case.

4.2.4.1.5.1 Test Case Indicator

The test case label (case_num, line 5a) was located at the beginning of the selected test case on line 5b. A goto start label was located at the end of each test case so that other test cases after the desired one would be skipped.

4.2.4.1.5.2 Data Input File Preparation

Within the goto labels the platform and data input data files were prepared and copied into compatible data file names used by the ATSG. Refer to Section 4.2.2 for information regarding input data file preparation.

4.2.4.1.6 Platform Movement Model Command Files

Below are the platform movement model command files (line 6). The command files themselves describe their use.

pmm_edit.com:

```
#! /bin/csh -f
# pmm_edit.com for one or two targets
# Used to edit the template platform_movement data file $1 using parameters $2t hru $8.
# ex:  pmm_edit.com platform_2tgts_2sens.dat  -500.0 0.01 0.020  10.0 0.01 0.020 10.0

echo $1 is being edited for
 echo " Aircraft Altitude    is represented by ACalt = $2 in feet"
 echo " Target Initial range  is represented by T1lat = $3 in degrees"
 echo " Target Initial range  is represented by T1lon = $4 in degrees"
 echo " Target 1 Speed       is represented by T1spd = $5 in kts"
 echo " Target Separation    is represented by T2lat = $6 in degrees"
 echo " Target Separation    is represented by T2lon = $7 in degrees"
 echo " Target 2 Speed       is represented by T2spd = $8 in kts"

echo "1,$ s/ACalt/$2/" > vboe
echo "1,$ s/T1lat/$3/" >> vboe
echo "1,$ s/T1lon/$4/" >> vboe
echo "1,$ s/T1spd/$5/" >> vboe
echo "1,$ s/T2lat/$6/" >> vboe
echo "1,$ s/T2lon/$7/" >> vboe
echo "1,$ s/T2spd/$8/" >> vboe
/usr/bin/sed -f vboe $1 > platform_data.dat0

echo "platform_data.dat0 is created from $1 with "
echo "T1lat,T2lat,TSPEED= $2, $3, $4 "
```

pmm_3tgt_edit.com:

```
#! /bin/csh -f

# pmm_edit.com for three targets

# Used to edit the template platform_movement data file $1 using parameters $2 thru $9.

# ex:  pmm_3tgt_edit.com pmm_par_to_east -500.0 0.01 0.020  0.01 0.020  0.01 0.020  10.0

echo $1 is being edited for
 echo " Aircraft Altitude     is represented by ACalt = $2 in feet"
 echo " Target Initial range  is represented by T1lat = $3 in degrees"
 echo " Target Initial range  is represented by T1lon = $4 in degrees"
 echo " Target 1 Speed        is represented by T1spd = $9 in kts"
 echo " Target Separation     is represented by T2lat = $5 in degrees"
 echo " Target Separation     is represented by T2lon = $6 in degrees"
 echo " Target 2 Speed        is represented by T2spd = $9 in kts"
 echo " Target Separation     is represented by T3lat = $7 in degrees"
 echo " Target Separation     is represented by T3lon = $8 in degrees"
 echo " Target 3 Speed        is represented by T3spd = $9 in kts"


echo "1,$ s/ACalt/$2/"  > vboe
echo "1,$ s/T1lat/$3/" >> vboe
echo "1,$ s/T1lon/$4/" >> vboe
echo "1,$ s/T2lat/$5/" >> vboe
echo "1,$ s/T2lon/$6/" >> vboe
echo "1,$ s/T3lat/$7/" >> vboe
echo "1,$ s/T3lon/$8/" >> vboe
echo "1,$ s/Tspd/$9/" >> vboe
/usr/bin/sed -f vboe $1 > platform_data.dat0

echo "platform_data.dat0 is created from $1 with "
echo "T1lat,T2lat,TSPEED= $2, $3, $4 "
```

4.2.4.1.7 Event File Indicator

Different event files were required depending upon the test case (line 7). The selected file was copied into event_data.dat and used to generate and compile scenario files. They are itemized in Section 4.2.2.1 and are listed in Appendix C.

4.2.4.2 Running the Command File and Its Results

During execution of the atsg_runs.com, the series of prompts and responses are as follows:

```
>atsg_runs.com

Running atsg_runs.com.  A command file to create selected scenario files.

The plot option is (0-no plot, 1- with burst page, 2- wo burst page, other- printer name)
The default plot option is  0.
Enter alternate  plot option or CR if no change,
0
The PLOT option is now 0.

Preprocess/compile option (0 no, 1 yes, 2 copy to testbed dire only)
The default compile/preprocess option is  1.
Enter alternate compile/preprocess option or CR if no change,
1
The compile/preprocess option is now 1.

5.1 MultiSensor Correlation Test Category 5  -  Test Case 1
.
.
.

Initializing msc_atsg.accum
The number of iterations is 15.
Enter alternate number of iterations or CR if no change,
15
Setting 15
The number of iterations is 15.

The starting scenario file number is 1.
Enter alternate scenario file number or CR if no change,
1
The starting scenario file number is now 1.

The default accum file number to output to is 1.
Enter alternate accum file number or CR if no change,
501
The accum file number is now 501.
At run termination, the msc_atsg.accum file will be copied to
msc_atsg.accum501
Starting iteration 1 of 15 with scenario file sf1.a
ATSG execution file is /usr/uiv/atsg/atsg_main_cm.exe
Running atsg_run.com.
.
.
.

atsg_runs.com ends
```

It was found that 15 iterations are sufficient to accurately sample nearly all test cases. Any instances where this was not believed to be true are indicated in the test case description, Section 3.3.

Any number could be used for the first scenario file number. Each subsequent scenario file number was then incremented by one. This scenario file number was used as the random seed which determines position perturbation.

A convention was used to name the accum files containing the concatenated extraction files. A three digit number was used. The first number indicated the test category. (Refer to Section 3.2.) The second two digits indicated the test case number. (Refer to Section 3.3.) This number was appended to the msc_atsg.accum file name which was used during the analysis phase. The scenario file numbers were identified in this file. To exactly duplicate a scenario test case, the random seed must also be duplicated.

Once all iterations of a test case were compiled and preprocessed, the testbed was run as described in the next section.

4.2.5 Run the Testbed for Each Iteration

Using the command file multi.com, Appendix E, the testbed was run. The series of prompts issued and their responses are illustrated in Figure 4.2.5 - 1.

Each test case was run one time to reject all correlation alerts and one time to accept all correlation and split track alerts (excluding those associated with track additions). Automatic rejection runs generated a maximum number of correlation test opportunities and were executed specifically for correlation performance and Type I error recovery categories. Automatic acceptance runs were executed specifically for fused track accuracy analysis and Type II error recovery categories.

```
testbed dire is <:/usr/uiv/production/testbed 32>multi.com
Be sure to terminate testbed by QUIT in CENTER of 'TESTDRIVER sce' window.
Your testbed library is /local.tb.imet/tms2d using intg.
Enter RETURN if correct, else CTRL C
The latest 15 scenario files in dire /intermetrics/zielinsk/production/testbed are:
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 19:12 sf15.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 18:33 sf14.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 17:54 sf13.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 17:17 sf12.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 16:39 sf11.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 16:01 sf10.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 15:22 sf9.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 14:43 sf8.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 14:04 sf7.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 13:25 sf6.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 12:47 sf5.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 12:08 sf4.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 11:29 sf3.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 10:50 sf2.a
-rwxrwxrwx 1 zielinsk 1088205 Dec 2 10:10 sf1.a

The number of iterations is 15.
Enter alternate number of iterations or CR if no change: 15
The number of iterations is 15.

The starting scenario file number is 101.
Enter alternate scenario file number or CR if no change: 1
The starting scenario file number is now 1.

This script will run the MSC testbed multiple times
using a different scenario file for each run.

Would you like to append the results to msc_model.accum after an iteration/run has completed?
y
The default accum file number to output to is 0.
Enter alternate accum file number or CR if no change: 501a
The accum file number is now 501a.
At run termination, the msc_model.accum file will be copied to
msc_model.accum501a

Would you like to use automatic answer?
Enter 1 to accept split track and correlations except reject correlations for new fix,
Enter 0 for NO automatic answer (default), and
Enter 2 to reject all correlations
1
Using generic_input_parameters_accept
Auto Accept option is 1
TSLI_STARTUP will be used to select the .prg file.
Starting iteration 1 with scenario file sf1.a
=====================================================
FIREUP TESTBED          Ver 3.11 (May 6, 1992)
```

Figure 4.2.5 - 1 - Example of multi.com

4.2.6 Analyze the Data

Using the command file anal.com, statistical reports and graphics for performance groups discussed in Section 3.2 were automatically generated. A series of prompts was issued asking the Test Category number and the Test Case number. One report file for the case and one for the iterations were generated for each of the three analysis categories. These categories are:

1. "re" for type error analysis for the "reject all" case,
2. "ae" for type error analysis for the "accept all" case, and
3. "aa" for accuracy analysis for the "accept all" case.

The reports are printed along with the associated plots including the following:

- The percent of Type I and Type II errors by iteration (See Section 6.2.1)
  These plots apply to Type Error Analyses only and provide an indication of the adequacy of the number of iterations. Since the percent is accumulative for the iterations, the latter iterations show the degree of stability in the results. Two continuous plots represent the accumulated total number of Type I errors divided by the opportunities and the total number of Type II errors divided by the opportunities respectively. The final values are reflected in the Run summaries of section 6.1.1 and 6.1.2.

- The fused track accuracy by iteration.(See Section 6.2.2)
  These plots apply to Accuracy Analyses only and provide an indication of the adequacy of the number of iterations. Since the percent is accumulative for the iterations, the latter iterations show the degree of stability in the results. One continuous plot represents the running average ratio of the RMS position error for all correctly fused tracks divided by the RMS error of the best of its components accumulated over the iteration.

- A time line of position error of fused tracks and the RMS position error of the fused tracks and their components.(See Section 6.2.3)
  These plots show the fusion accuracy as a function of time with the "*" symbols . At the right side of the plot, the overall RMS of the each sensor for each iteration is shown by an upper case letter representing the sensor ("R" for radar, "V" for visual, etc) . Each sensor symbol is offset a bit from the others in the time axis to avoid overprinting for different sensors. The RMS

error for the fused tracks is also shown offset more to the right using the "&" symbol for each iteration. These plots are shown for each target. The distribution of the Fused RMS errors should lie somewhat lower than the distribution of RMS errors of the best sensor components. Feet is plotted against seconds.

- The time line of position error of all position errors (See Section 6.2.4)
  These plots show the same as the above with the addition of the individual time line component position errors of sensor components. They are labeled by lower case letters representing the sensor ("r" for radar, "v" for visual, etc)

- The time line of velocity error of fused tracks and RMS velocity errors. (See Section 6.2.5)
  These plots are the same as in section 6.2.3 but for velocity. Knots is plotted against seconds.

- The time line all velocity errors (See Section 6.2.6). These plots are the same as in section 6.2.4 but for velocity. Knots is plotted against seconds.

5.0 RESULTS AND CONCLUSIONS

5.1 Results

5.1.1 Summary

Each test case was run one time to reject all correlation alerts and one time to accept all correlation and split track alerts (except those associated with new sensor track additions). Automatic rejection runs generated a maximum number of correlation test opportunities and were executed specifically for correlation performance and Type I error recovery categories. Automatic acceptance runs were executed specifically for fused track accuracy analysis and Type II error recovery categories.

5.1.2 Preliminary Comments

Two aspects of the test procedures impact the results for Correlation Performance and Type I and Type II Error Recovery:

a. Data was gathered through the entirety of each run, whereas in actual use the operator would ignore correlation data from sensor tracks that have not yet converged.

b. The need for operator intervention was eliminated by automatically answering Correlation and Split Track alerts.

Thus, this system of algorithms was tested without the aid of human judgement. Including the operator in the system would improve overall performance. However, an intent of these tests was to examine unaided performance for reliable results, since feeding statistically unreliable recommendations to the operator would minimize the utility of these algorithms.

5.1.3 Correlation Performance

Tables 5.1.3 - 1 through 5.1.3 - 6 summarize correlation performance.

CORRELATION PERFORMANCE

CATEGORY / CASE	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8
Number of iterations	15	15	15	15	15	15	15	15

Automatic Rejection of All Correlation Alerts

Number of Correct Accepts	5764	5761	5315	5240	3773	5332	5273	6842
Number of Incorrect Accepts (Type II Errors)	0	0	452	539	2003	453	510	353
Number of Correct Rejects	5790	5790	1721	1882	200	1368	1935	8927
Number of Incorrect Rejects (Type I Errors)	26	29	35	36	46	11	8	152
Type I Error Probability	0.0045	0.0050	0.0065	0.0068	0.0120	0.0021	0.0015	0.0189
Type II Error Probability	0.0000	0.0000	0.2080	0.2226	0.9092	0.2488	0.2086	0.0380

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Correct Accepts	5776	5769	5399	5783	3092	5401	4247	6306
Number of Incorrect Accepts (Type II Errors)	0	0	387	4	2697	20	1444	920
Number of Correct Rejects	45	45	10	8	5	372	108	114
Number of Incorrect Rejects (Type I Errors)	14	21	2	3	0	1	0	36
Type I Error Probability	0.0024	0.0050	0.0004	0.0005	0.0000	0.0002	0.0000	0.0057
Type II Error Probability	0.0000	0.0000	0.9748	0.3333	0.9981	0.9490	0.9304	0.8897

Table 5.1.3 - 1 - Correlation Performance Results

CORRELATION PERFORMANCE

CATEGORY / CASE	1/9	1/10	1/11	1/12	1/27	1/28		
Number of iterations	15	15	15	15	15	15		

Automatic Rejection of All Correlation Alerts

Number of Correct Accepts	5268	5761	785	1703	5364	4367		
Number of Incorrect Accepts (Type II Errors)	521	0	82	55	421	1420		
Number of Correct Rejects	1774	5790	268	1055	2109	370		
Number of Incorrect Rejects (Type I Errors)	25	29	5	15	14	15		
Type I Error Probability	0.0047	0.0050	0.0063	0.0087	0.0026	0.0034		
Type II Error Probability	0.2270	0.0000	0.00002	0.00028	0.1664	0.7933		

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Correct Accepts	3409	5769	550	1692	3088	4243		
Number of Incorrect Accepts (Type II Errors)	1874	0	262	50	2526	1532		
Number of Correct Rejects	123	45	61	32	180	13		
Number of Incorrect Rejects (Type I Errors)	0	21	2	1	0	2		
Type I Error Probability	0.0000	0.0036	0.0036	0.0006	0.0000	0.0005		
Type II Error Probability	0.9384	0.0000	0.8111	0.6098	0.9335	0.9916		

Table 5.1.3 - 2 - Correlation Performance Results

CORRELATION PERFORMANCE

CATEGORY / CASE	2/1	2/2						
Number of iterations	15	15						

Automatic Rejection of All Correlation Alerts

Number of Correct Accepts	5741	5663						
Number of Incorrect Accepts (Type II Errors)	24	52						
Number of Correct Rejects	5492	5501						
Number of Incorrect Rejects (Type I Errors)	25	76						
Type I Error Probability	0.0043	0.0132						
Type II Error Probability	0.0045	0.0094						

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Correct Accepts	5680	5293						
Number of Incorrect Accepts (Type II Errors)	54	320						
Number of Correct Rejects	76	171						
Number of Incorrect Rejects (Type I Errors)	3	31						
Type I Error Probability	0.0005	0.0058						
Type II Error Probability	0.4154	0.6817						

Table 5.1.3 - 3 - Correlation Performance Results

CORRELATION PERFORMANCE

CATEGORY / CASE	3/1	3/2	3/3	3/4				
Number of iterations	15	15	15	15				

Automatic Rejection of All Correlation Alerts

Number of Correct Accepts	5733	5774	7198	7197				
Number of Incorrect Accepts (Type II Errors)	0	0	0	0				
Number of Correct Rejects	5788	5790	14368	14370				
Number of Incorrect Rejects (Type I Errors)	37	16	97	155				
Type I Error Probability	0.0064	0.0028	0.0133	0.0211				
Type II Error Probability	0.0000	0.0000	0.0000	0.0000				

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Correct Accepts	5789	5790	7229	7229				
Number of Incorrect Accepts (Type II Errors)	0	0	0	0				
Number of Correct Rejects	43	45	133	136				
Number of Incorrect Rejects (Type I Errors)	1	0	10	66				
Type I Error Probability	0.0002	0.0000	0.0014	0.0090				
Type II Error Probability	0.0000	0.0000	0.0000	0.0000				

Table 5.1.3 - 4 - Correlation Performance Results

CORRELATION PERFORMANCE

CATEGORY / CASE	4/1	4/2	4/3	4/4		4/10	4/11	4/12
Number of iterations	15	15	15	15		5	5	5

Automatic Rejection of All Correlation Alerts

Number of Correct Accepts	2876	6224	2893	3134		240	445	240
Number of Incorrect Accepts (Type II Errors)	0	0	0	0		0	0	0
Number of Correct Rejects	0	0	0	0		0	0	0
Number of Incorrect Rejects (Type I Errors)	19	31	2	34		3	4	3
Type I Error Probability	0.0066	0.0010	0.0007	0.0107		0.0123	0.0089	0.0123
Type II Error Probability	--	--	--	--		--	--	--

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Correct Accepts	2895	3180	2895	3150		244	449	245
Number of Incorrect Accepts (Type II Errors)	0	0	0	0		0	0	0
Number of Correct Rejects	0	0	0	0		0	0	0
Number of Incorrect Rejects (Type I Errors)	0	3	0	2		6	6	0
Type I Error Probability	0.0000	0.0006	0.0000	0.0006		0.0240	0.01320	0.0000
Type II Error Probability	--	--	--	--		--	--	--

Table 5.1.3 - 5 - Correlation Performance Results

CORRELATION PERFORMANCE

CATEGORY / CASE	5/1	5/2	5/3					
Number of iterations	15	15	15					

Automatic Rejection of All Correlation Alerts

Number of Correct Accepts	0	0	0					
Number of Incorrect Accepts (Type II Errors)	74	0	4277					
Number of Correct Rejects	11041	11115	6838					
Number of Incorrect Rejects (Type I Errors)	0	0	0					
Type I Error Probability	--	--	--					
Type II Error Probability	0.0067	0.0000	0.3848					

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Correct Accepts	0	0	0					
Number of Incorrect Accepts (Type II Errors)	157	0	5184					
Number of Correct Rejects	10825	11115	5743					
Number of Incorrect Rejects (Type I Errors)	0	0	0					
Type I Error Probability	--	--	--					
Type II Error Probability	.01430	0.0000	0.4740					

Table 5.1.3 - 6 - Correlation Performance Results

5.1.4 Type I Error Recovery

Tables 5.1.4 - 1 through 5.1.4 - 6 summarize Type I error recovery.

TYPE I ERROR RECOVERY

CATEGORY / CASE	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8
Number of iterations	15	15	15	15	15	15	15	15

Automatic Rejection of All Correlation Alerts

Number of Incorrect26 Rejects (#IR)		29	35	36	46	11	8	132
Number of Eventual Accepts (#EA)	9	4	7	5	9	6	4	27
Recover Rate (#EA / #IR)	0.346	0.138	0.200	0.179	0.196	0.545	0.500	0.205
Total Number of Updates*	26	29	35	28	46	11	8	132
Average Num of Updates Before Error Recovery**	2.9	7.3	.0	5.6	5.1	1.8	2.0	4.9

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)

** - #UIR / #EA

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect14 Rejects (#IR)		21	2	3	0	1	0	36
Number of Eventual Accepts (#EA)	4	3	2	3	0	1	0	2
Recover Rate (#EA / #IR)	0.286	0.103	1.00	1.00	0.00	1.00	0.00	0.057
Total Number of Updates*	14	21	2	3	0	1	0	35
Average Num of Updates Before Error Recovery**	35	7.0	1.0	1.0	0.0	1.0	0.0	17.5

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)

** - #UIR / #EA

Table 5.1.4 - 1 - Type I Error Recovery Results

TYPE I ERROR RECOVERY

CATEGORY / CASE1/9		1/10	1/11	1/12	1/27	1/28		
Number of iterations	15	15	15	15	15	15		

Automatic Rejection of All Correlation Alerts

Number of Incorrect Rejects (#IR)	25	29	5	15	14	15		
Number of Eventual Accepts (#EA)	5	4	3	3	4	4		
Recover Rate (#EA / #IR)	0.200	0.138	0.600	0.200	0.286	0.266		
Total Number of Updates*	25	29	5	10	14	15		
Average Num of Updates Before Error Recovery**	5.0	7.3	1.7	3.3	3.5	3.8		

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect Rejects (#IR)	0	21	2	1	0	2		
Number of Eventual Accepts (#EA)	0	3	1	1	0	2		
Recover Rate (#EA / #IR)	0	0.143	0.500	1.00	0	1.00		
Total Number of Updates*	0	21	2	1	0	2		
Average Num of Updates Before Error Recovery**	0	7.0	2.0	1.0	0	1.0		

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Table 5.1.4 - 2 - Type I Error Recovery Results

TYPE I ERROR RECOVERY

CATEGORY / CASE	2/1	2/2						
Number of iterations	15	15						

Automatic Rejection of All Correlation Alerts

Number of Incorrect25 Rejects (#IR)		76						
Number of Eventual Accepts (#EA)	3	11						
Recover Rate (#EA / #IR)	0.120	0.145						
Total Number of Updates*	25	65						
Average Num of Updates Before Error Recovery**	8.3	5.9						

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect3 Rejects (#IR)		31						
Number of Eventual Accepts (#EA)	3	4						
Recover Rate (#EA / #IR)	1.00	0.129						
Total Number of Updates*	3	31						
Average Num of Updates Before Error Recovery**	1.0	7.8						

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Table 5.1.4 - 3 - Type I Error Recovery Results

TYPE I ERROR RECOVERY

CATEGORY / CASE	3/1	3/2	3/3	3/4				
Number of iterations	15	15	15	15				

Automatic Rejection of All Correlation Alerts

Number of Incorrect37 Rejects (#IR)		16	97	155				
Number of Eventual Accepts (#EA)	7	7	21	24				
Recover Rate (#EA / #IR)	0.189	0.438	0.216	0.155				
Total Number of Updates*	37	16	97	140				
Average Num of Updates Before Error Recovery**	5.3	2.3	4.6	5.8				

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect1 Rejects (#IR)		0	10	66				
Number of Eventual Accepts (#EA)	1	0	7	4				
Recover Rate (#EA / #IR)	1.00	0.00	0.700	0.061				
Total Number of Updates*	1	0.00	10	66				
Average Num of Updates Before Error Recovery**	1.0	0.0	1.4	16.5				

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Table 5.1.4 - 4 - Type I Error Recovery Results

TYPE I ERROR RECOVERY

CATEGORY / CASE4/1		4/2	4/3	4/4		4/10	4/11	4/12
Number of iterations	15	15	15	15		5	5	5
Automatic Rejection of All Correlation Alerts								
Number of Incorrect Rejects (#IR)	19	31	2	34		3	4	3
Number of Eventual Accepts (#EA)	5	11	1	11		3	4	2
Recover Rate (#EA / #IR)	0.263	0.355	0.500	0.324		1.000	1.000	0.666
Total Number of Updates*	19	30	2	2		3	4	2
Average Num of Updates Before Error Recovery**	3.8	2.7	2.0	2.4		1.0	1.0	1.0
Automatic Acceptance of All Correlation and Split Track Alerts								
Number of Incorrect Rejects (#IR)	0	3	2	2		6	6	0
Number of Eventual Accepts (#EA)	0	3	2	2		5	5	0
Recover Rate (#EA / #IR)	0	1.00	1.00	2		0.833	0.833	0.000
Total Number of Updates*	0	3	2	2		6	6	0
Average Num of Updates Before Error Recovery**	0	1.0	1.0	1.0		1.2	1.2	–

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Table 5.1.4 - 5 - Type I Error Recovery Results

TYPE I ERROR RECOVERY

CATEGORY / CASE	5/1	5/2	5/3						
Number of iterations	15	15	15						

Automatic Rejection of All Correlation Alerts

Number of Incorrect0 Rejects (#IR)		0	0						
Number of Eventual Accepts (#EA)	0	0	0						
Recover Rate (#EA / #IR)	0	0	0						
Total Number of Updates*	0	0	0						
Average Num of Updates Before Error Recovery**	0	0	0						

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect0 Rejects (#IR)		0	0						
Number of Eventual Accepts (#EA)	0	0	0						
Recover Rate (#EA / #IR)	0	0	0						
Total Number of Updates*	0	0	0						
Average Num of Updates Before Error Recovery**	0	0	0						

* - Total number of updates involving an incorrect reject leading to an eventual accept (#UIR)
** - #UIR / #EA

Table 5.1.4 - 6 - Type I Error Recovery Results

5.1.5 Type II Error Recovery

Table 5.1.5 - 1 through 5.1.5 - 6 summarize Type II error recovery.

TYPE II ERROR RECOVERY

CATEGORY / CASE Number of iterations	1/1 15	1/2 15	1/3 15	1/4 15	1/5 15	1/6 15	1/7 15	1/8 15

Automatic Rejection of All Correlation Alerts

Number of Incorrect Accepts (#IA)	0	0	452	539	2003	453	510	353
Number of Eventual Rejects (#ER)	0	0	366	492	1503	381	467	155
Recover Rate (#ER / #IA)	0	0	0.810	.0913	0.750	0.841	0.91	0.439
Total Number of Updates*	0	0	451	539	1996	438	508	336
Average Num of Updates Before Error Recovery**	0	0	1.2	1.1	1.3	1.2	1.1	2.2

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect Accepts (#IA)	0	0	387	4	2697	372	1444	920
Number of Eventual Rejects (#ER)	0	0	7	4	5	6	5	1
Recover Rate (#ER / #IA)	0	0	0.018	1.00	0.002	0.016	0.003	0.001
Total Number of Updates*	0	0	132	4	10	6	9	4
Average Num of Updates Before Error Recovery**	0	0	18.9	1.0	2.0	1.1	1.8	4.0

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Table 5.1.5 - 1 - Type II Error Recovery Results

TYPE II ERROR RECOVERY

CATEGORY / CASE	1/9	1/10	1/11	1/12	1/27	1/28		
Number of iterations	15	15	15	15	15	15		

Automatic Rejection of All Correlation Alerts

Number of Incorrect521 Accepts (#IA)		0	82	55	421	1420		
Number of Eventual Rejects (#ER)	452	0	68	42	391	1186		
Recover Rate (#ER / #IA)	0.868	0.00	0.829	0.764	0.929	0.835		
Total Number of Updates*	518	0	81	54	420	1415		
Average Num of Updates Before Error Recovery**	1.1	0.0	1.2	1.3	1.1	1.2		

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)
** - #UIA / #ER

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect1874 Accepts (#IA)		0	262	50	2526	1532		
Number of Eventual Rejects (#ER)	24	0	33	17	26	7		
Recover Rate (#ER / #IA)	0.013	0.00	0.126	0.340	0.010	0.005		
Total Number of Updates*	304	0	99	50	661	8		
Average Num of Updates Before Error Recovery**	12.7	0.0	3.0	2.9	25.4	1.1		

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)
** - #UIA / #ER

Table 5.1.5 - 2 - Type II Error Recovery Results

TYPE II ERROR RECOVERY

CATEGORY / CASE	2/1	2/2						
Number of iterations	15	15						

Automatic Rejection of All Correlation Alerts

Number of Incorrect Accepts (#IA)	24	52						
Number of Eventual Rejects (#ER)	22	25						
Recover Rate (#ER / #IA)	0.917	0.481						
Total Number of Updates*	24	52						
Average Num of Updates Before Error Recovery**	1.1	2.1						

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect Accepts (#IA)	54	320						
Number of Eventual Rejects (#ER)	5	8						
Recover Rate (#ER / #IA)	0.093	0.025						
Total Number of Updates*	54	68						
Average Num of Updates Before Error Recovery**	10.8	8.5						

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Table 5.1.5 - 3 - Type II Error Recovery Results

TYPE II ERROR RECOVERY

CATEGORY / CASE	3/1	3/2	3/3	3/4				
Number of iterations	15	15	15	15				

Automatic Rejection of All Correlation Alerts

Number of Incorrect0 Accepts (#IA)		0	0	0				
Number of Eventual Rejects (#ER)	0	0	0	0				
Recover Rate (#ER / #IA)	0	0	0	0				
Total Number of Updates*	0	0	0	0				
Average Num of Updates Before Error Recovery**	0	0	0	0				

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect0 Accepts (#IA)		0	0	0				
Number of Eventual Rejects (#ER)	0	0	0	0				
Recover Rate (#ER / #IA)	0	0	0	0				
Total Number of Updates*	0	0	0	0				
Average Num of Updates Before Error Recovery**	0	0	0	0				

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Table 5.1.5 - 4 - Type II Error Recovery Results

TYPE II ERROR RECOVERY

CATEGORY / CASE4/1		4/2	4/3	4/4		4/10	4/11	/412
Number of iterations	15	15	15	15		5	5	5

Automatic Rejection of All Correlation Alerts

Number of Incorrect Accepts (#IA)	0	0	0	0		0	0	0
Number of Eventual Rejects (#ER)	0	0	0	0		0	0	0
Recover Rate (#ER / #IA)	0	0	0	0		0	0	0
Total Number of Updates*	0	0	0	0		0	0	0
Average Num of Updates Before Error Recovery**	0	0	0	0		0	0	0

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect Accepts (#IA)	0	0	0	0		0	0	0
Number of Eventual Rejects (#ER)	0	0	0	0		0	0	0
Recover Rate (#ER / #IA)	0	0	0	0		0	0	0
Total Number of Updates*	0	0	0	0		0	0	0
Average Num of Updates Before Error Recovery**	0	0	0	0		0	0	0

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Table 5.1.5 - 5 - Type II Error Recovery Results

TYPE II ERROR RECOVERY

CATEGORY / CASE	5/1	5/2	5/3					
Number of iterations	15	15	15					

Automatic Rejection of All Correlation Alerts

Number of Incorrect74 Accepts (#IA)		0	4277					
Number of Eventual Rejects (#ER)	18	0	196					
Recover Rate (#ER / #IA)	0.243	0.00	0.046					
Total Number of Updates*	71	0	3466					
Average Num of Updates Before Error Recovery**	3.9	0.0	17.7					

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Automatic Acceptance of All Correlation and Split Track Alerts

Number of Incorrect157 Accepts (#IA)		0	5184					
Number of Eventual Rejects (#ER)	19	0	33					
Recover Rate (#ER / #IA)	0.121	0.00	0.006					
Total Number of Updates*	49	0	1143					
Average Num of Updates Before Error Recovery**	2.6	0.0	34.6					

* - Total number of updates involving an incorrect accept leading to an eventual reject (#UIA)

** - #UIA / #ER

Table 5.1.5 - 6 - Type II Error Recovery Results

5.1.6 Fused Track Accuracy

Tables 5.1.6 - 1 through 5.1.6 - 2 summarize fused track accuracy.

PERCENTAGE IMPROVEMENT IN FUSED TRACK ACCURACY

Automatic Acceptance of All Correlation and Split Track Alerts
(Average Percent Improvement of Fused Track over their Best Component)

CATEGORY / CASE Number of iterations	1/1 15	1/2 15	1/3 15	1/4 15	1/5 15	1/6 15	1/7 15	1/8 15
Position	9.76	11.26	13.39	1.91	28.86	23.0	8.51	7.78
Speed	3.27	8.43	6.24	1.43	21.65	12.46	2.46	4.07

CATEGORY / CASE Number of iterations	1/9 15	1/10 15	1/11 15	1/12 15	1/27 15	1/28 15		
Position	13.18	11.26	20.93	25.74	9.31	15.41		
Speed	9.92	8.43	4.70	20.29	6.79	7.65		

Table 5.1.6 - 1 - Fused Track Accuracy Results

PERCENTAGE IMPROVEMENT IN FUSED TRACK ACCURACY

Automatic Acceptance of All Correlation and Split Track Alerts
(Average Percent Improvement of Fused Track over their Best Component)

CATEGORY / CASE Number of iterations	2/1 15	2/2 15						
Position	9.09	4.39						
Speed	4.93	0.42						

CATEGORY / CASE Number of iterations	3/1 15	3/2 15	3/3 15	3/4 15				
Position	13.75	11.18	1.56	7.18				
Speed	6.19	5.50	-0.59	4.06				

CATEGORY / CASE Number of iterations	4/1 15	4/2 15	4/3 15	4/4 15		4/10 5	4/11 5	4/12 5
Position	8.46	-29.29	15.16	-23.25		-29.97	-11.35	-30.00
Speed	3.30	-22.56	9.52	-11.55		-20.28	-1.53	-20.30

CATEGORY / CASE Number of iterations	5/1 15	5/2 15	5/3 15					
Position	N/F*	N/F*	N/F*					
Speed	N/F*	N/F*	N/F*					

* - No Correctly Fused Tracks

Table 5.1.6 - 2 - Fused Track Accuracy Results

5.1.7 Mean Radial Circular Uncertainty (MRCU)

Data from scenario "Category 1, Case 4" were used to examine this statistic. The graphs in Figures 5.1.7 - 1 and 5.1.7 - 2 show the values for both true position error and MRCU that were computed in the scenario's first iteration. Tables 5.1.7 - 1 and 5.1.7 - 2 show that the MRCU overestimates the size of the Area of Uncertainty (AOU), but this assures that the probability that a target is within a given region is as good as or better than the theoretical probability.

5.1.8 Normalized Error

The examination of normalized error also used data from test scenario "Category 1, Case 4". Table 5.1.7 - 1 and Table 5.1.7 -2 show that this statistic conforms to the chi-square random variable with two degrees of freedom; and this indicates that the fused tracker was properly designed and implemented.

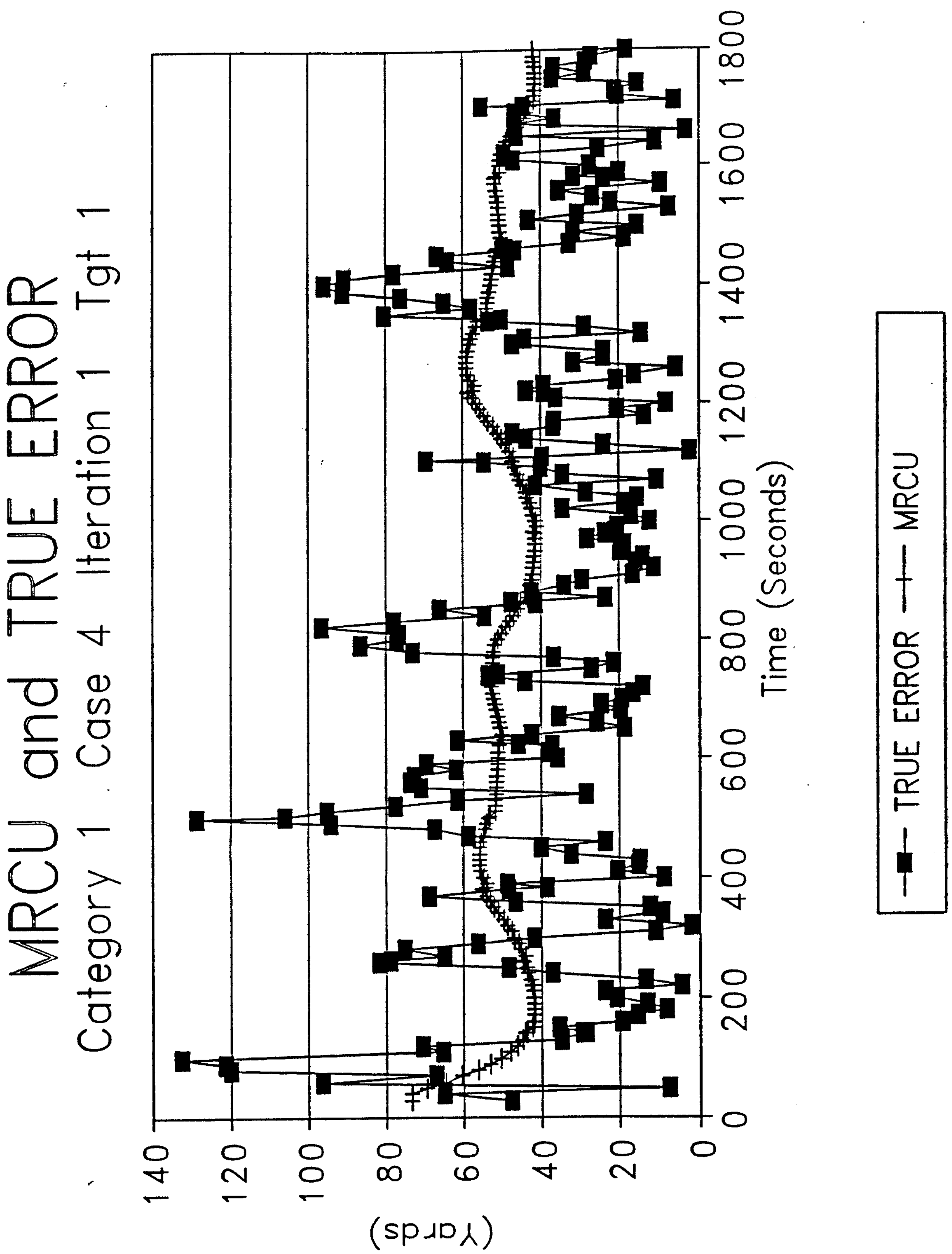

Figure 5.1.7 - 1 - MRCU and True Error for Target 1

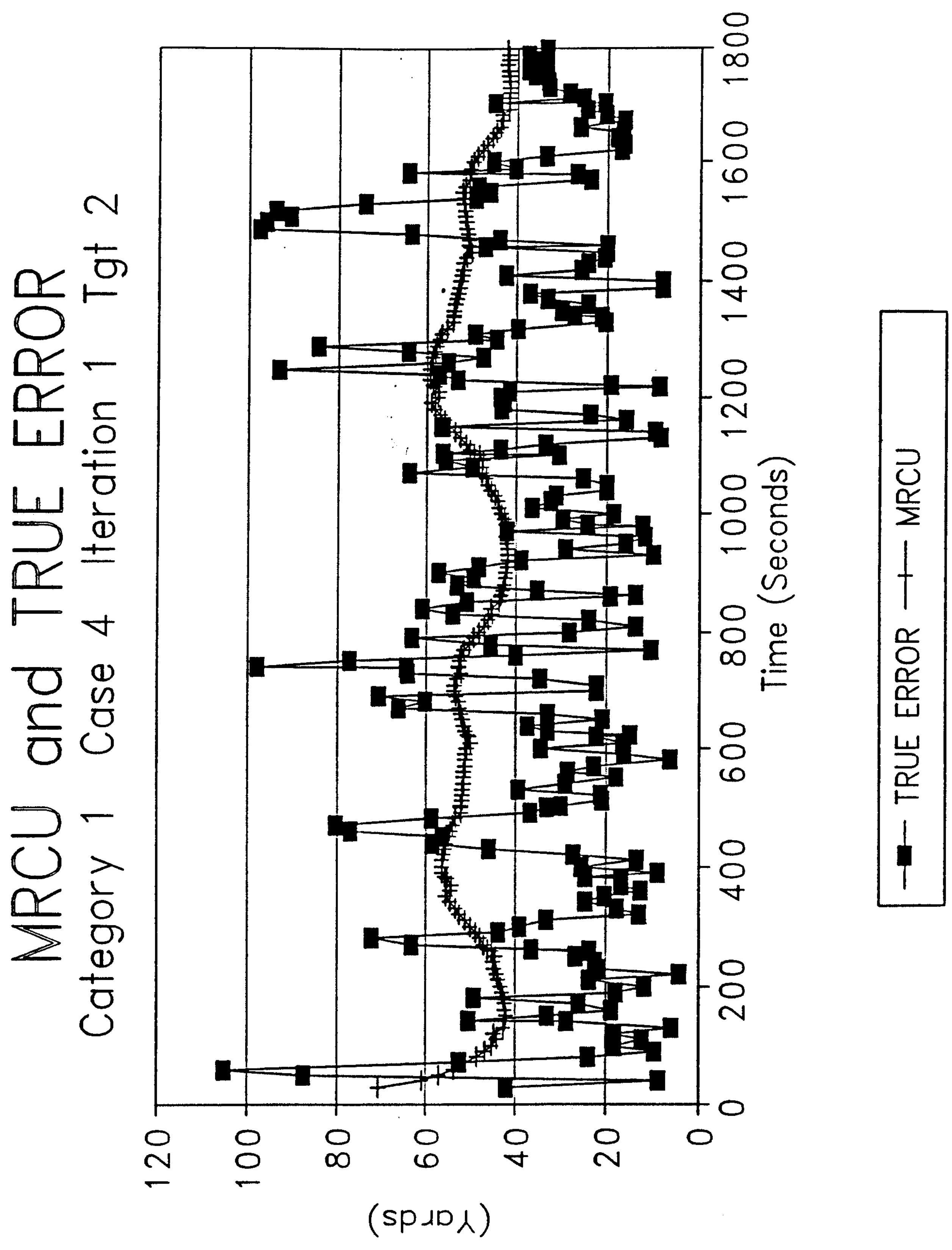

Figure 5.1.7 - 2 - MRCU and True Error for Target 2

MEAN RADIAL CIRCULAR UNCERTAINTY and NORMALIZED ERROR PERFORMANCE CATEGORIES SUMMARY

for

Test Category 1 Test Case 4

	MRCU vs TRUE ERROR Target 1					NORMALIZED ERROR Target 1			
		# Samples Within 1*MRCU	# Samples Within 1.1774* MRCU	# Samples Within 2.448* MRCU		ERROR DISTRIBUTION			
Iteration	# Samples	(40% Area)	(50% Area)	(95% Area)		# Samples	0-9.9%	10-89.9%	90-100%
1	192	138	149	191		192	23	154	15
2	191	147	165	191		191	0	49	12
3	192	153	171	192		192	23	161	8
4	192	137	152	192		192	20	162	10
5	187	140	152	182		187	17	149	21
6	177	135	144	177		177	28	143	6
7	192	133	145	191		192	13	166	13
8	192	143	161	191		192	26	152	14
9	192	159	172	191		192	29	158	5
10	192	152	174	192		192	31	155	6
11	192	120	132	190		192	24	146	22
12	192	151	171	192		192	19	168	5
13	192	148	165	192		192	25	154	13
14	192	165	175	192		192	35	154	3
15	192	142	161	192		192	31	155	6
	2859	2163	2389	2848		2859	374	2326	159
Percentages(%)		75.66	83.56	9.62	Percentages(%)		13.08	81.36	5.56

Table 5.1.7 - 1 - MRCU and NE Results for Target 1

MEAN RADIAL CIRCULAR UNCERTAINTY and NORMALIZED ERROR PERFORMANCE CATEGORIES SUMMARY
for
Test Category 1 Test Case 4

MRCU vs TRUE ERROR
Target 2

NORMALIZED ERROR
Target 2

		# Samples Within 1*MRCU	# Samples Within 1.1774* MRCU	# Samples Within 2.448* MRCU		ERROR DISTRIBUTION		
Iteration	# Samples	(40% Area)	(50% Area)	(95% Area)	# Samples	0-9.9%	10-89.9%	90-100%
1	192	148	163	192	192	23	158	11
2	192	149	167	192	192	29	160	3
3	192	146	160	192	192	27	158	7
4	192	131	145	192	192	20	157	15
5	192	151	160	191	192	1	140	21
6	192	151	166	192	192	34	152	6
7	192	153	170	192	192	33	158	1
8	192	170	179	192	192	34	157	1
9	192	128	147	192	192	19	166	7
10	192	127	153	192	192	14	169	9
11	192	149	164	192	192	15	163	14
12	192	153	165	192	192	22	168	2
13	192	159	173	192	192	29	156	7
14	192	147	164	191	192	26	156	10
15	192	145	162	192	192	22	161	9
	2880	2207	2438	2878	2880	378	2379	123
Percentages(%)		76.63	84.65	99.93	Percentages(%)	13.13	82.60	4.27

Table 5.1.7 - 2 - MRCU and NE Results for Target 2

5.2 Conclusions

Ref: (a) P-3 Update IV Multi-Sensor Correlation; May 1989 paper, Robert Fritz, Oricon Corporation

(b) Test Of Fusion Algorithm; 11 Jul 1989 memorandum #3620-89-059, Pat Kavanaugh, Oricon Corporation

(c) Multiple Target Tracking With Radar Applications; 1986 text, Samuel Blackman

(d) Evaluation of Mission Avionics Sensor Synergism (MASS) project; 1989-1991, NADC

(e) Implementation Of Branch And Bound For Realtime Processing; 21 Apr 1989 memorandum, William Bailey, NADC

(f) Fuzzy Logic Concepts For Multi-Sensor Tracking; 1993 Independent Research project, Dr. Ram Singh, William Bailey, NAWC

(g) Multitarget-Multisensor Tracking; 1990 text, Yaakov Bar-Shalom editor

5.2.1 Summary

As stated in the introduction to this report and in reference (a), the MSC algorithms were designed to reduce operator workload by combining multiple sensor contact reports and multiple sensor tracks from a single target into a single and ideally more accurate track. These tests and reference (b) demonstrated that with simulated data the algorithms do indeed produce a more accurate fused track when the component contact reports and tracks are correctly combined. However, the utility of these algorithms is minimized by their high false correlation (type II error) rate.

5.2.2 False Correlation Problem

The results of these tests support the statement in chapter 4 of reference (c) that the sequential nearest-neighbor approach to data association used by these algorithms can lead to miscorrelations. Reference (c) asserts and reference (d) showed that supplementing the MSC chi-square score & selection function with an optimal

assignment (n x n pairing) function would "expand the region of unambiguous correlation". Reference (a) acknowledges that MSC lacks optimal assignment logic. This is partially justified by noting that Update IV software employs an unconstrained global polling scheme to compare a new tactical object with all other objects in the tactical database, and optimal assignment logic requires the maintaining and polling of tactical objects in groups of the same type and time frame. Therefore, adding optimal assignment logic to the MSC algorithms would necessitate a database management overhaul.

The algorithms of reference (d) handled fused track initiation and fused track update differently. They used chi-square score & selection / optimal assignment logic to initiate fused tracks, and they produced good results with simulated data and a small set of real data. However they used chi-square score & selection / nearest neighbor logic, similar to that employed by MSC, to associate and update a fused track with data from an unassociated sensor contact. In this case, they produced results with high false correlation rates. (There were no problems with updating a fused track with a contact report from a sensor with which it was associated from initiation.) Consequently it was proposed to abandon the attempt to combine unassociated sensor contact reports with fused tracks. Instead it was proposed to periodically execute the fused track initiation function to account for new unassociated contacts and potential split tracks.

The algorithms of reference (d) employed the branch and bound algorithm to perform optimal assignments. The branch and bound algorithm has a potential to consume an unacceptable amount of time and computer memory space. Reference (e) offers a solution to this problem. It customized an implementation of the algorithm by adding time and memory constraints. If the constraints are reached, the customized algorithm returns the best solution so far. The customized version produced the same solution as the unconstrained version in numerous test cases.

Reference (f) is developing an optimal assignment algorithm that executes in realtime. It proposes to use fuzzy logic concepts to uncover mappings from the spaces of the two sets of tactical objects to their assignment space.

Approaches to the assignment problem are also found in reference (c), chapters 4 and 9, and reference (g), chapter 7.

APPENDIX A

A.0 Specific Test Results

Results of the MSC tests are listed by Case summary, in section A.1 below. All case summaries refer to the test category and case number as tabulated in the Test Case Grid (Table 3.3.3-1) .

Plots of results are provided in section A.2. All are labeled by analysis number code in form nmmxy where

n is the test category,
mm is the test case,
x is either "r" for Reject_All, or "a" for accept all, and
y is either "e" for Type Error Analysis or "a" for Accuracy Analysis.

A.1 Run Summaries

Run summaries are given in two types, Type I and II Error Analysis (TEA), and Accuracy analysis. TEA summaries can come from "Reject-all" or "Accept-all" testbed runs. These three analysis categories (having analysis number codes ending in "re", "ae", and "aa" respectively) are arranged in separate sections A.1.1 through A.1.3 respectively.

A.1.1 Run Summaries for Reject-All Type Error Analyses (re)

A.1.2 Run Summaries for Accept-All Type Error Analyses (ae)

A.1.3 Run Summaries for Accept-All Accuracy Analyses (aa)

A.2 Plots

Plots are provided to show the following:

- The percent of Type I and Type II errors by iteration, (A.2.1).
- The fused track accuracy by iteration, (A.2.2).
- The time line of position error of fused tracks and the RMS position error of the fused tracks and their components, (A.2.3).
- The time line of position error of all position errors, (A.2.4).
- The time line of velocity error of fused tracks and RMS velocity errors, (A.2.5).
- The time line all velocity errors, (A.2.6).

A.2.1 Percent of Type I and Type II errors by iteration

A.2.2 Fused track accuracy by iteration

A.2.3 Time line of position error of fused tracks and RMS position errors.

A.2.4 Time line of all position errors

A.2.5 Time line of velocity error of fused tracks and RMS velocity errors.

A.2.6 Time line for all velocity errors

Appendix B

Scenario File Generation Scripts

```
#! /bin/csh -f
# Find and move the        start:        line to control run.

echo " "
echo "Running atsg_runs.com.  A command file to create selected scenario files."
# Plotting, Compilation, and preprocessing is optional.
echo " "

# This script can be customized by modifying the variables below.
#################################################################
# This script takes no parameters but calls atsg_run.com passing the
# following parameters:

# The 1st five parameters to atsg_run.com are used for file name codes.
#  p1:  input file event_data.dat$1
#  p2:  input file platform_data.dat$2
#  p3:  input file emitter_data.dat$3
#  p4:  input file test_code.dat$4
#  P5:  output scenario file sf$5.a

#  P6:  Plot option: Set this option to plot the platform trajectories
#     (0-no plot, 1- with burst page, 2- wo burst page, other- printer name)
 setenv PLOT  0
 #setenv PLOT  1
 #setenv PLOT  2
 #setenv PLOT  crusherlw
 #setenv PLOT  wesleylw
echo "The plot option is (0-no plot, 1- with burst page, 2- wo burst page, other-
printer name)"
echo "The default plot option is  $PLOT."
echo "Enter alternate  plot option or CR if no change, "
set answer = $<
# echo answer is $answer.
```

```
if ($answer != "") then
 set PLOT  = $answer
  echo "The PLOT option is now $PLOT."
endif
  echo " "


# P7: Preprocess option: Set this option to compile/preprocess/copy the
#       scenario files. (0 no,  1 yes, 2 copy to testbed dire only)
setenv COMPILE  1
echo "Preprocess/compile option (0 no, 1 yes, 2 copy to testbed dire only)"
echo "The default compile/preprocess option is  $COMPILE."
echo "Enter alternate compile/preprocess option or CR if no change, "
set answer = $<
# echo answer is $answer.
if ($answer != "") then
 set COMPILE  = $answer
  echo "The compile/preprocess option is now $COMPILE."
endif
  echo " "

# P8: The full path to the directory where the ATSG data
#       files reside and the scenario files will be produced.
1 setenv ATSGDATA ~uiv/production/atsg

# P9: The full paths to the directory where the ATSG executable resides.
2 setenv ATSGEXEC ~uiv/production/atsg

# P10: The full path to the directory where the testbed is run (without
#       debugger) and (optionally) the scenario files will be copied,
#       compiled, and preprocessed.  The scenario files (.a and .cmd) will also
#      be copied to a debug subdirectory of this testbed directory.
3 setenv TESTBED ~uiv/production/testbed
###########################################################
##
# The variable below is the full path to the ATSG execution script file.
```

setenv ATSGRUN ~banowetz/tools/atsg_run.com
##
##

4 goto case_num

---

echo "1. MultiSensor Correlation Test Category 1 - Test Case 4"
Call the command file to update the necessary input file(s)
pmm_edit.com platform_para_para.dat400 -500.0 0.133091 -0.166376 10.0 0.133091 -0.169115 10.0

cp ~zielinsk/production/atsg/event_data_2tgts_2sens.dat event_data.dat0

$ATSGDATA/event_data.dat0

Go to start and do 50 iterations of the test case
goto start

4a case_num:

echo "1. MultiSensor Correlation Test Category 1 - Test Case 2"
Call the command file to update the necessary input file(s)

5 pmm_edit.com platform_para_perp.dat400 -500.0 0.166376 -0.831882 10.0 0.168430 -0.831882 10.0

6 cp ~uiv/production/atsg/event_data_2tgts_2sens.dat event_data.dat0

Go to start and do multiple iterations of the test case
goto start

---

start:

~uiv/production/testbed/msc_record.com

```
echo "Initializing msc_atsg.accum"
echo "msc_atsg.accum" > msc_atsg.accum
date >> msc_atsg.accum

# Set the number of iterations to run
set MAXITER = 15
echo "The number of iterations is $MAXITER."
echo "Enter alternate number of iterations or CR if no change, "
set answer = $<
# echo You entered $answer
if ($answer != "") then
  echo Setting $answer
  set  MAXITER = $answer
   echo "The number of iterations is $MAXITER."
endif

# Set the starting scenario file number (# for sf#.a and sf#.cmd)
echo " "
set sf_num = 401
echo "The starting scenario file number is $sf_num."
echo "Enter alternate scenario file number or CR if no change, "
set answer = $<
if ($answer != "") then
  set sf_num  = $answer
   echo "The starting scenario file number is now $sf_num."
endif

# Set the accum file number (# for output msc_atsg.accum)
set ACCUM = 1
echo " "
echo "The default accum file number to output to is $ACCUM."
echo "Enter alternate accum file number or CR if no change, "
set answer = $<
```

```
if ($answer != "") then
 set ACCUM  = $answer
  echo "The accum file number is now $ACCUM."
   echo At run termination, the msc_atsg.accum file will be copied to
   echo msc_atsg.accum$ACCUM
endif

# initialize the counter
set count = 1
echo "Test 12 ACCUM = $ACCUM , sf_num = $sf_num , MAXITER = $MAXITER "
>> test.log


while ($count <= $MAXITER)

  echo "Starting iteration $count of $MAXITER with scenario file sf$sf_num.a"

 4b $ATSGRUN 0 0 0 0 $sf_num $PLOT $COMPILE $ATSGDATA $ATSGEXEC
$TESTBED


  #  Append results to extraction file
  echo Scenario sf$sf_num.a  >> msc_atsg.accum
  cat text_extract_file.out  >> msc_atsg.accum
  echo "End_of_iter_run"      >> msc_atsg.accum
 date                   >> msc_atsg.accum


  # increment the counters
  set count = `expr $count + 1`
  set sf_num = `expr $sf_num + 1`

#end of test case -- ie end of while
end

# VLB
```

```
cp msc_atsg.accum msc_atsg.accum$ACCUM
echo "End_of_case">> msc_atsg.accum$ACCUM
echo msc_atsg.accum$ACCUM is built.
date >> test.log
echo "msc_atsg.accum$ACCUM is built" >> test.log
echo " " >> test.log

echo test 1 ends before count = $count of $MAXITER
goto endit

endit:
echo "atsg_runs.com ends"
```

atsg_run.com

```
#! /bin/csh -f
# atsg_run.com:  Run the ATSG and (optionally) plot trajectories, compile the
# scenario file and preprocess the scenario file.

# Parm 1 is the numeric index for the scenario file creation.
echo "Running atsg_run.com.   "
# A command file to create/compile/preprocess a selected scenario file.
echo "event $1, plat $2, emit $3, test_code $4, "
echo "Scenario $5, Plot code $6, compile flag $7"
# Plot code $6 is 0- no plot,  1 with burst page, 2- no burst page
echo "ATSG data dire is $8 "
echo "Dire for ATSG execution is $9 "
echo "Testbed dire is $10 "
# The testbed debug dire must be a subdirectory of the testbed directory $10."

cd $9
rm  scenario_file.a
rm  event_data.dat
rm  platform_data.dat
rm  emitter_data.dat
rm  plot_file.dat

echo "Copying data files  for ATSG"
cp $8/event_data.dat$1    $9/event_data.dat
cp $8/platform_data.dat$2 $9/platform_data.dat
cp $8/emitter_data.dat$3  $9/emitter_data.dat
cp $8/test_code.dat$4     $9/generic_input_parameters

echo  "chmod"
chmod 777 $9/event_data.dat
chmod 777 $9/platform_data.dat
chmod 777 $9/emitter_data.dat
chmod 777 $9/generic_input_parameters
```

```
echo  Using random number $5
echo "Rand_Init $5" >>  $9/generic_input_parameters

echo " "
echo Running atsg_main.exe
echo  using test data in $8/test_code.dat$4 in $cwd = $9
echo " "

rm -f warn.note

~banowetz/geordi/atsg/atsg_main_cm.exe
if (-e warn.note) then
  echo -n "ATSG warn.note copied to test.log for ."
  echo "event $1, plat $2, emit $3, test_code $4, "
  echo "Scenario $5, Plot code $6, compile flag $7"
  echo -n "ATSG warn.note copied to test.log for ." >> test.log
  echo "event $1, plat $2, emit $3, test_code $4, " >> test.log
  echo "Scenario $5, Plot code $6, compile flag $7" >> test.log
  cat warn.note >> test.log
endif

# Perform logging
echo " " >> atsg_log.out
date >> atsg_log.out
echo -n "sf$5.a being generated from $1 $2 $3 $4 " >> atsg_log.out
cat log.out >> atsg_log.out


~banowetz/geordi/atsg/sort_grep.com $6

if ($7 > 0)  then
  echo "Copying sf$5.a to testbed directory $10."
  cp scenario_file.a $10/sf$5.a
  if ($7 == 1) then
   cd $10
```

```
   echo "Compiling and preprocessing sf$5.a in testbed dire using Chris Hand's
preprocessor"
   ~banowetz/generic/ada/genada.com sf$5.a A S 0 | more
   #  preprocess sf$5.a
   echo Use Chris Hand  binary edited preprocessor
   ~tbtools/bin/preprocess_1450  sf$5.a
   # Copy scenario file to debug directory if there is one.
   if (-e debug) cp sf$5.* debug
   cd $9
  endif
endif

endit:
echo "end atsg_run.com on sf$5.a"
echo " "
```

Appendix C

Event Template Files

```
deterministic
1800.0   1450
1   20.0   Manual_Radar   0   true   false   false
1   22.0   VISUAL   0   true   false   false
1   30.0   Manual_Radar   0   true   false   false
1   40.0   Manual_Radar   0   true   false   false
1   50.0   Manual_Radar   0   true   false   false
1   60.0   Manual_Radar   0   true   false   false
1   70.0   Manual_Radar   0   true   false   false
1   80.0   Manual_Radar   0   true   false   false
1   90.0   Manual_Radar   0   true   false   false
1   100.0   Manual_Radar   0   true   false   false
1   110.0   Manual_Radar   0   true   false   false
1   120.0   Manual_Radar   0   true   false   false
1   130.0   Manual_Radar   0   true   false   false
1   140.0   Manual_Radar   0   true   false   false
1   142.0   VISUAL   0   true   false   false
1   150.0   Manual_Radar   0   true   false   false
1   160.0   Manual_Radar   0   true   false   false
1   170.0   Manual_Radar   0   true   false   false
1   180.0   Manual_Radar   0   true   false   false
1   190.0   Manual_Radar   0   true   false   false
1   200.0   Manual_Radar   0   true   false   false
1   210.0   Manual_Radar   0   true   false   false
1   220.0   Manual_Radar   0   true   false   false
1   230.0   Manual_Radar   0   true   false   false
1   240.0   Manual_Radar   0   true   false   false
1   250.0   Manual_Radar   0   true   false   false
1   260.0   Manual_Radar   0   true   false   false
1   262.0   VISUAL   0   true   false   false
1   270.0   Manual_Radar   0   true   false   false
1   280.0   Manual_Radar   0   true   false   false
1   290.0   Manual_Radar   0   true   false   false
1   300.0   Manual_Radar   0   true   false   false
1   310.0   Manual_Radar   0   true   false   false
1   320.0   Manual_Radar   0   true   false   false
1   330.0   Manual_Radar   0   true   false   false
1   340.0   Manual_Radar   0   true   false   false
1   350.0   Manual_Radar   0   true   false   false
1   360.0   Manual_Radar   0   true   false   false
1   370.0   Manual_Radar   0   true   false   false
1   380.0   Manual_Radar   0   true   false   false
1   382.0   VISUAL   0   true   false   false
1   390.0   Manual_Radar   0   true   false   false
```

1	400.0	Manual_Radar	0	true	false	false
1	410.0	Manual_Radar	0	true	false	false
1	420.0	Manual_Radar	0	true	false	false
1	430.0	Manual_Radar	0	true	false	false
1	440.0	Manual_Radar	0	true	false	false
1	450.0	Manual_Radar	0	true	false	false
1	460.0	Manual_Radar	0	true	false	false
1	470.0	Manual_Radar	0	true	false	false
1	480.0	Manual_Radar	0	true	false	false
1	490.0	Manual_Radar	0	true	false	false
1	500.0	Manual_Radar	0	true	false	false
1	502.0	VISUAL	0	true	false	false
1	510.0	Manual_Radar	0	true	false	false
1	520.0	Manual_Radar	0	true	false	false
1	530.0	Manual_Radar	0	true	false	false
1	540.0	Manual_Radar	0	true	false	false
1	550.0	Manual_Radar	0	true	false	false
1	560.0	Manual_Radar	0	true	false	false
1	570.0	Manual_Radar	0	true	false	false
1	580.0	Manual_Radar	0	true	false	false
1	590.0	Manual_Radar	0	true	false	false
1	600.0	Manual_Radar	0	true	false	false
1	610.0	Manual_Radar	0	true	false	false
1	620.0	Manual_Radar	0	true	false	false
1	622.0	VISUAL	0	true	false	false
1	630.0	Manual_Radar	0	true	false	false
1	640.0	Manual_Radar	0	true	false	false
1	650.0	Manual_Radar	0	true	false	false
1	660.0	Manual_Radar	0	true	false	false
1	670.0	Manual_Radar	0	true	false	false
1	680.0	Manual_Radar	0	true	false	false
1	690.0	Manual_Radar	0	true	false	false
1	700.0	Manual_Radar	0	true	false	false
1	710.0	Manual_Radar	0	true	false	false
1	720.0	Manual_Radar	0	true	false	false
1	730.0	Manual_Radar	0	true	false	false
1	740.0	Manual_Radar	0	true	false	false
1	742.0	VISUAL	0	true	false	false
1	750.0	Manual_Radar	0	true	false	false
1	760.0	Manual_Radar	0	true	false	false
1	770.0	Manual_Radar	0	true	false	false
1	780.0	Manual_Radar	0	true	false	false
1	790.0	Manual_Radar	0	true	false	false
1	800.0	Manual_Radar	0	true	false	false
1	810.0	Manual_Radar	0	true	false	false
1	820.0	Manual_Radar	0	true	false	false

1	830.0	Manual_Radar	0	true	false	false
1	840.0	Manual_Radar	0	true	false	false
1	850.0	Manual_Radar	0	true	false	false
1	860.0	Manual_Radar	0	true	false	false
1	862.0	VISUAL	0	true	false	false
1	870.0	Manual_Radar	0	true	false	false
1	880.0	Manual_Radar	0	true	false	false
1	890.0	Manual_Radar	0	true	false	false
1	900.0	Manual_Radar	0	true	false	false
1	910.0	Manual_Radar	0	true	false	false
1	920.0	Manual_Radar	0	true	false	false
1	930.0	Manual_Radar	0	true	false	false
1	940.0	Manual_Radar	0	true	false	false
1	950.0	Manual_Radar	0	true	false	false
1	960.0	Manual_Radar	0	true	false	false
1	970.0	Manual_Radar	0	true	false	false
1	980.0	Manual_Radar	0	true	false	false
1	982.0	VISUAL	0	true	false	false
1	990.0	Manual_Radar	0	true	false	false
1	1000.0	Manual_Radar	0	true	false	false
1	1010.0	Manual_Radar	0	true	false	false
1	1020.0	Manual_Radar	0	true	false	false
1	1030.0	Manual_Radar	0	true	false	false
1	1040.0	Manual_Radar	0	true	false	false
1	1050.0	Manual_Radar	0	true	false	false
1	1060.0	Manual_Radar	0	true	false	false
1	1070.0	Manual_Radar	0	true	false	false
1	1080.0	Manual_Radar	0	true	false	false
1	1090.0	Manual_Radar	0	true	false	false
1	1100.0	Manual_Radar	0	true	false	false
1	1102.0	VISUAL	0	true	false	false
1	1110.0	Manual_Radar	0	true	false	false
1	1120.0	Manual_Radar	0	true	false	false
1	1130.0	Manual_Radar	0	true	false	false
1	1140.0	Manual_Radar	0	true	false	false
1	1150.0	Manual_Radar	0	true	false	false
1	1160.0	Manual_Radar	0	true	false	false
1	1170.0	Manual_Radar	0	true	false	false
1	1180.0	Manual_Radar	0	true	false	false
1	1190.0	Manual_Radar	0	true	false	false
1	1200.0	Manual_Radar	0	true	false	false
1	1210.0	Manual_Radar	0	true	false	false
1	1220.0	Manual_Radar	0	true	false	false
1	1222.0	VISUAL	0	true	false	false
1	1230.0	Manual_Radar	0	true	false	false
1	1240.0	Manual_Radar	0	true	false	false

1	1250.0	Manual_Radar	0	true	false	false
1	1260.0	Manual_Radar	0	true	false	false
1	1270.0	Manual_Radar	0	true	false	false
1	1280.0	Manual_Radar	0	true	false	false
1	1290.0	Manual_Radar	0	true	false	false
1	1300.0	Manual_Radar	0	true	false	false
1	1310.0	Manual_Radar	0	true	false	false
1	1320.0	Manual_Radar	0	true	false	false
1	1330.0	Manual_Radar	0	true	false	false
1	1340.0	Manual_Radar	0	true	false	false
1	1342.0	VISUAL	0	true	false	false
1	1350.0	Manual_Radar	0	true	false	false
1	1360.0	Manual_Radar	0	true	false	false
1	1370.0	Manual_Radar	0	true	false	false
1	1380.0	Manual_Radar	0	true	false	false
1	1390.0	Manual_Radar	0	true	false	false
1	1400.0	Manual_Radar	0	true	false	false
1	1410.0	Manual_Radar	0	true	false	false
1	1420.0	Manual_Radar	0	true	false	false
1	1430.0	Manual_Radar	0	true	false	false
1	1440.0	Manual_Radar	0	true	false	false
1	1450.0	Manual_Radar	0	true	false	false
1	1460.0	Manual_Radar	0	true	false	false
1	1462.0	VISUAL	0	true	false	false
1	1470.0	Manual_Radar	0	true	false	false
1	1480.0	Manual_Radar	0	true	false	false
1	1490.0	Manual_Radar	0	true	false	false
1	1500.0	Manual_Radar	0	true	false	false
1	1510.0	Manual_Radar	0	true	false	false
1	1520.0	Manual_Radar	0	true	false	false
1	1530.0	Manual_Radar	0	true	false	false
1	1540.0	Manual_Radar	0	true	false	false
1	1550.0	Manual_Radar	0	true	false	false
1	1560.0	Manual_Radar	0	true	false	false
1	1570.0	Manual_Radar	0	true	false	false
1	1580.0	Manual_Radar	0	true	false	false
1	1582.0	VISUAL	0	true	false	false
1	1590.0	Manual_Radar	0	true	false	false
1	1600.0	Manual_Radar	0	true	false	false
1	1610.0	Manual_Radar	0	true	false	false
1	1620.0	Manual_Radar	0	true	false	false
1	1630.0	Manual_Radar	0	true	false	false
1	1640.0	Manual_Radar	0	true	false	false
1	1650.0	Manual_Radar	0	true	false	false
1	1660.0	Manual_Radar	0	true	false	false
1	1670.0	Manual_Radar	0	true	false	false

1	1680.0	Manual_Radar	0	true	false	false
1	1690.0	Manual_Radar	0	true	false	false
1	1700.0	Manual_Radar	0	true	false	false
1	1702.0	VISUAL	0	true	false	false
1	1710.0	Manual_Radar	0	true	false	false
1	1720.0	Manual_Radar	0	true	false	false
1	1730.0	Manual_Radar	0	true	false	false
1	1740.0	Manual_Radar	0	true	false	false
1	1750.0	Manual_Radar	0	true	false	false
1	1760.0	Manual_Radar	0	true	false	false
1	1770.0	Manual_Radar	0	true	false	false
1	1780.0	Manual_Radar	0	true	false	false
1	1790.0	Manual_Radar	0	true	false	false
1	1800.0	Manual_Radar	0	true	false	false
1	1810.0	Manual_Radar	0	true	false	false
1	1820.0	Manual_Radar	0	true	false	false
1	1822.0	VISUAL	0	true	false	false
1	1830.0	Manual_Radar	0	true	false	false
1	1840.0	Manual_Radar	0	true	false	false
1	1850.0	Manual_Radar	0	true	false	false
1	1860.0	Manual_Radar	0	true	false	false
1	1870.0	Manual_Radar	0	true	false	false
1	1880.0	Manual_Radar	0	true	false	false
1	1890.0	Manual_Radar	0	true	false	false
1	1900.0	Manual_Radar	0	true	false	false
1	1910.0	Manual_Radar	0	true	false	false
1	1920.0	Manual_Radar	0	true	false	false
1	1930.0	Manual_Radar	0	true	false	false
1	1940.0	Manual_Radar	0	true	false	false
1	1942.0	VISUAL	0	true	false	false
1	1950.0	Manual_Radar	0	true	false	false
1	1960.0	Manual_Radar	0	true	false	false
1	1970.0	Manual_Radar	0	true	false	false
1	1980.0	Manual_Radar	0	true	false	false
1	1990.0	Manual_Radar	0	true	false	false
1	2000.0	Manual_Radar	0	true	false	false

0
No_Action

No_Action

trash

Assign_NATO_Name 45.0
May be Correlation alert.

deterministic
1800.0 1450

1	20.0	Manual_Radar	0	true	false	false
1	22.0	MAD	0	true	false	false
1	24.0	VISUAL	0	true	false	false
1	30.0	Manual_Radar	0	true	false	false
1	40.0	Manual_Radar	0	true	false	false
1	50.0	Manual_Radar	0	true	false	false
1	60.0	Manual_Radar	0	true	false	false
1	70.0	Manual_Radar	0	true	false	false
1	80.0	Manual_Radar	0	true	false	false
1	82.0	MAD	0	true	false	false
1	90.0	Manual_Radar	0	true	false	false
1	100.0	Manual_Radar	0	true	false	false
1	110.0	Manual_Radar	0	true	false	false
1	120.0	Manual_Radar	0	true	false	false
1	130.0	Manual_Radar	0	true	false	false
1	140.0	Manual_Radar	0	true	false	false
1	144.0	VISUAL	0	true	false	false
1	150.0	Manual_Radar	0	true	false	false
1	160.0	Manual_Radar	0	true	false	false
1	170.0	Manual_Radar	0	true	false	false
1	180.0	Manual_Radar	0	true	false	false
1	190.0	Manual_Radar	0	true	false	false
1	200.0	Manual_Radar	0	true	false	false
1	202.0	MAD	0	true	false	false
1	210.0	Manual_Radar	0	true	false	false
1	220.0	Manual_Radar	0	true	false	false
1	230.0	Manual_Radar	0	true	false	false
1	240.0	Manual_Radar	0	true	false	false
1	250.0	Manual_Radar	0	true	false	false
1	260.0	Manual_Radar	0	true	false	false
1	264.0	VISUAL	0	true	false	false
1	270.0	Manual_Radar	0	true	false	false
1	280.0	Manual_Radar	0	true	false	false
1	290.0	Manual_Radar	0	true	false	false
1	300.0	Manual_Radar	0	true	false	false
1	310.0	Manual_Radar	0	true	false	false
1	320.0	Manual_Radar	0	true	false	false
1	322.0	MAD	0	true	false	false
1	330.0	Manual_Radar	0	true	false	false
1	340.0	Manual_Radar	0	true	false	false
1	350.0	Manual_Radar	0	true	false	false
1	360.0	Manual_Radar	0	true	false	false

1	370.0	Manual_Radar	0	true	false	false
1	380.0	Manual_Radar	0	true	false	false
1	384.0	VISUAL	0	true	false	false
1	390.0	Manual_Radar	0	true	false	false
1	400.0	Manual_Radar	0	true	false	false
1	410.0	Manual_Radar	0	true	false	false
1	420.0	Manual_Radar	0	true	false	false
1	430.0	Manual_Radar	0	true	false	false
1	440.0	Manual_Radar	0	true	false	false
1	442.0	MAD	0	true	false	false
1	450.0	Manual_Radar	0	true	false	false
1	460.0	Manual_Radar	0	true	false	false
1	470.0	Manual_Radar	0	true	false	false
1	480.0	Manual_Radar	0	true	false	false
1	490.0	Manual_Radar	0	true	false	false
1	500.0	Manual_Radar	0	true	false	false
1	504.0	VISUAL	0	true	false	false
1	510.0	Manual_Radar	0	true	false	false
1	520.0	Manual_Radar	0	true	false	false
1	530.0	Manual_Radar	0	true	false	false
1	540.0	Manual_Radar	0	true	false	false
1	550.0	Manual_Radar	0	true	false	false
1	560.0	Manual_Radar	0	true	false	false
1	562.0	MAD	0	true	false	false
1	570.0	Manual_Radar	0	true	false	false
1	580.0	Manual_Radar	0	true	false	false
1	590.0	Manual_Radar	0	true	false	false
1	600.0	Manual_Radar	0	true	false	false
1	610.0	Manual_Radar	0	true	false	false
1	620.0	Manual_Radar	0	true	false	false
1	624.0	VISUAL	0	true	false	false
1	630.0	Manual_Radar	0	true	false	false
1	640.0	Manual_Radar	0	true	false	false
1	650.0	Manual_Radar	0	true	false	false
1	660.0	Manual_Radar	0	true	false	false
1	670.0	Manual_Radar	0	true	false	false
1	680.0	Manual_Radar	0	true	false	false
1	682.0	MAD	0	true	false	false
1	690.0	Manual_Radar	0	true	false	false
1	700.0	Manual_Radar	0	true	false	false
1	710.0	Manual_Radar	0	true	false	false
1	720.0	Manual_Radar	0	true	false	false
1	730.0	Manual_Radar	0	true	false	false
1	740.0	Manual_Radar	0	true	false	false
1	744.0	VISUAL	0	true	false	false
1	750.0	Manual_Radar	0	true	false	false

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1	780.0	Manual_Radar	0	true	false	false
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1	800.0	Manual_Radar	0	true	false	false
1	802.0	MAD	0	true	false	false
1	810.0	Manual_Radar	0	true	false	false
1	820.0	Manual_Radar	0	true	false	false
1	830.0	Manual_Radar	0	true	false	false
1	840.0	Manual_Radar	0	true	false	false
1	850.0	Manual_Radar	0	true	false	false
1	860.0	Manual_Radar	0	true	false	false
1	864.0	VISUAL	0	true	false	false
1	870.0	Manual_Radar	0	true	false	false
1	880.0	Manual_Radar	0	true	false	false
1	890.0	Manual_Radar	0	true	false	false
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1	920.0	Manual_Radar	0	true	false	false
1	922.0	MAD	0	true	false	false
1	930.0	Manual_Radar	0	true	false	false
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1	950.0	Manual_Radar	0	true	false	false
1	960.0	Manual_Radar	0	true	false	false
1	970.0	Manual_Radar	0	true	false	false
1	980.0	Manual_Radar	0	true	false	false
1	984.0	VISUAL	0	true	false	false
1	990.0	Manual_Radar	0	true	false	false
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1	1010.0	Manual_Radar	0	true	false	false
1	1020.0	Manual_Radar	0	true	false	false
1	1030.0	Manual_Radar	0	true	false	false
1	1040.0	Manual_Radar	0	true	false	false
1	1042.0	MAD	0	true	false	false
1	1050.0	Manual_Radar	0	true	false	false
1	1060.0	Manual_Radar	0	true	false	false
1	1070.0	Manual_Radar	0	true	false	false
1	1080.0	Manual_Radar	0	true	false	false
1	1090.0	Manual_Radar	0	true	false	false
1	1100.0	Manual_Radar	0	true	false	false
1	1104.0	VISUAL	0	true	false	false
1	1110.0	Manual_Radar	0	true	false	false
1	1120.0	Manual_Radar	0	true	false	false
1	1130.0	Manual_Radar	0	true	false	false
1	1140.0	Manual_Radar	0	true	false	false
1	1150.0	Manual_Radar	0	true	false	false

1	1160.0	Manual_Radar	0	true	false	false
1	1162.0	MAD	0	true	false	false
1	1170.0	Manual_Radar	0	true	false	false
1	1180.0	Manual_Radar	0	true	false	false
1	1190.0	Manual_Radar	0	true	false	false
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1	1210.0	Manual_Radar	0	true	false	false
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1	1224.0	VISUAL	0	true	false	false
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1	1240.0	Manual_Radar	0	true	false	false
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1	1270.0	Manual_Radar	0	true	false	false
1	1280.0	Manual_Radar	0	true	false	false
1	1282.0	MAD	0	true	false	false
1	1290.0	Manual_Radar	0	true	false	false
1	1300.0	Manual_Radar	0	true	false	false
1	1310.0	Manual_Radar	0	true	false	false
1	1320.0	Manual_Radar	0	true	false	false
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1	1340.0	Manual_Radar	0	true	false	false
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1	1370.0	Manual_Radar	0	true	false	false
1	1380.0	Manual_Radar	0	true	false	false
1	1390.0	Manual_Radar	0	true	false	false
1	1400.0	Manual_Radar	0	true	false	false
1	1402.0	MAD	0	true	false	false
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1	1480.0	Manual_Radar	0	true	false	false
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1	1520.0	Manual_Radar	0	true	false	false
1	1522.0	MAD	0	true	false	false
1	1530.0	Manual_Radar	0	true	false	false
1	1540.0	Manual_Radar	0	true	false	false

1	1550.0	Manual_Radar	0	true	false	false
1	1560.0	Manual_Radar	0	true	false	false
1	1570.0	Manual_Radar	0	true	false	false
1	1580.0	Manual_Radar	0	true	false	false
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1	1600.0	Manual_Radar	0	true	false	false
1	1610.0	Manual_Radar	0	true	false	false
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1	1630.0	Manual_Radar	0	true	false	false
1	1640.0	Manual_Radar	0	true	false	false
1	1642.0	MAD	0	true	false	false
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1	1660.0	Manual_Radar	0	true	false	false
1	1670.0	Manual_Radar	0	true	false	false
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1	1690.0	Manual_Radar	0	true	false	false
1	1700.0	Manual_Radar	0	true	false	false
1	1704.0	VISUAL	0	true	false	false
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1	1720.0	Manual_Radar	0	true	false	false
1	1730.0	Manual_Radar	0	true	false	false
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1	1750.0	Manual_Radar	0	true	false	false
1	1760.0	Manual_Radar	0	true	false	false
1	1762.0	MAD	0	true	false	false
1	1770.0	Manual_Radar	0	true	false	false
1	1780.0	Manual_Radar	0	true	false	false
1	1790.0	Manual_Radar	0	true	false	false
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1	1824.0	VISUAL	0	true	false	false
1	1830.0	Manual_Radar	0	true	false	false
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1	1870.0	Manual_Radar	0	true	false	false
1	1880.0	Manual_Radar	0	true	false	false
1	1882.0	MAD	0	true	false	false
1	1890.0	Manual_Radar	0	true	false	false
1	1900.0	Manual_Radar	0	true	false	false
1	1910.0	Manual_Radar	0	true	false	false
1	1920.0	Manual_Radar	0	true	false	false
1	1930.0	Manual_Radar	0	true	false	false
1	1940.0	Manual_Radar	0	true	false	false

1	1944.0	VISUAL	0	true	false	false
1	1950.0	Manual_Radar	0	true	false	false
1	1960.0	Manual_Radar	0	true	false	false
1	1970.0	Manual_Radar	0	true	false	false
1	1980.0	Manual_Radar	0	true	false	false
1	1990.0	Manual_Radar	0	true	false	false
1	2000.0	Manual_Radar	0	true	false	false
1	2002.0	MAD	0	true	false	false

0
No_Action

No_Action

```
deterministic
1800.0   1450
1   20.0   Manual_Radar   0   true   false   false
2   20.0   Manual_Radar   0   true   false   false
1   22.0   VISUAL         0   true   false   false
2   22.0   VISUAL         0   true   false   false
1   30.0   Manual_Radar   0   true   false   false
2   30.0   Manual_Radar   0   true   false   false
1   40.0   Manual_Radar   0   true   false   false
2   40.0   Manual_Radar   0   true   false   false
1   50.0   Manual_Radar   0   true   false   false
2   50.0   Manual_Radar   0   true   false   false
1   60.0   Manual_Radar   0   true   false   false
2   60.0   Manual_Radar   0   true   false   false
1   70.0   Manual_Radar   0   true   false   false
2   70.0   Manual_Radar   0   true   false   false
1   80.0   Manual_Radar   0   true   false   false
2   80.0   Manual_Radar   0   true   false   false
1   90.0   Manual_Radar   0   true   false   false
2   90.0   Manual_Radar   0   true   false   false
1   100.0  Manual_Radar   0   true   false   false
2   100.0  Manual_Radar   0   true   false   false
1   110.0  Manual_Radar   0   true   false   false
2   110.0  Manual_Radar   0   true   false   false
1   120.0  Manual_Radar   0   true   false   false
2   120.0  Manual_Radar   0   true   false   false
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2   130.0  Manual_Radar   0   true   false   false
1   140.0  Manual_Radar   0   true   false   false
2   140.0  Manual_Radar   0   true   false   false
1   142.0  VISUAL         0   true   false   false
2   142.0  VISUAL         0   true   false   false
1   150.0  Manual_Radar   0   true   false   false
2   150.0  Manual_Radar   0   true   false   false
1   160.0  Manual_Radar   0   true   false   false
2   160.0  Manual_Radar   0   true   false   false
1   170.0  Manual_Radar   0   true   false   false
2   170.0  Manual_Radar   0   true   false   false
1   180.0  Manual_Radar   0   true   false   false
2   180.0  Manual_Radar   0   true   false   false
1   190.0  Manual_Radar   0   true   false   false
2   190.0  Manual_Radar   0   true   false   false
1   200.0  Manual_Radar   0   true   false   false
2   200.0  Manual_Radar   0   true   false   false
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1	260.0	Manual_Radar	0	true	false	false
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1	262.0	VISUAL	0	true	false	false
2	262.0	VISUAL	0	true	false	false
1	270.0	Manual_Radar	0	true	false	false
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1	280.0	Manual_Radar	0	true	false	false
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1	382.0	VISUAL	0	true	false	false
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1	502.0	VISUAL	0	true	false	false
2	502.0	VISUAL	0	true	false	false
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1	620.0	Manual_Radar	0	true	false	false
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1	622.0	VISUAL	0	true	false	false
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1	742.0	VISUAL	0	true	false	false
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1	760.0	Manual_Radar	0	true	false	false
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1	1100.0	Manual_Radar	0	true	false	false
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2	1102.0	VISUAL	0	true	false	false
1	1110.0	Manual_Radar	0	true	false	false
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1	1120.0	Manual_Radar	0	true	false	false
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1	1140.0	Manual_Radar	0	true	false	false
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1	1190.0	Manual_Radar	0	true	false	false
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1	1280.0	Manual_Radar	0	true	false	false
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1	1340.0	Manual_Radar	0	true	false	false
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1	1462.0	VISUAL	0	true	false	false
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1	1480.0	Manual_Radar	0	true	false	false
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1	1580.0	Manual_Radar	0	true	false	false
2	1580.0	Manual_Radar	0	true	false	false
1	1582.0	VISUAL	0	true	false	false
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1	1590.0	Manual_Radar	0	true	false	false
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1	1600.0	Manual_Radar	0	true	false	false
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1	1690.0	Manual_Radar	0	true	false	false
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1	1820.0	Manual_Radar	0	true	false	false
2	1820.0	Manual_Radar	0	true	false	false
1	1822.0	VISUAL	0	true	false	false
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1	1840.0	Manual_Radar	0	true	false	false
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1	1930.0	Manual_Radar	0	true	false	false
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1	1940.0	Manual_Radar	0	true	false	false
2	1940.0	Manual_Radar	0	true	false	false
1	1942.0	VISUAL	0	true	false	false
2	1942.0	VISUAL	0	true	false	false
1	1950.0	Manual_Radar	0	true	false	false
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1	1960.0	Manual_Radar	0	true	false	false
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1	1980.0	Manual_Radar	0	true	false	false
2	1980.0	Manual_Radar	0	true	false	false
1	1990.0	Manual_Radar	0	true	false	false
2	1990.0	Manual_Radar	0	true	false	false
1	2000.0	Manual_Radar	0	true	false	false
2	2000.0	Manual_Radar	0	true	false	false

0
No_Action

No_Action

trash

Assign_NATO_Name 45.0
May be Correlation alert.

deterministic
1800.0 1450

1	20.0	Manual_Radar	0	true	false	false
2	20.0	Manual_Radar	0	true	false	false
1	22.0	MAD	0	true	false	false
2	22.0	MAD	0	true	false	false
1	24.0	VISUAL	0	true	false	false
2	24.0	VISUAL	0	true	false	false
1	30.0	Manual_Radar	0	true	false	false
2	30.0	Manual_Radar	0	true	false	false
1	32.0	MAD	0	true	false	false
2	32.0	MAD	0	true	false	false
1	40.0	Manual_Radar	0	true	false	false
2	40.0	Manual_Radar	0	true	false	false
1	42.0	MAD	0	true	false	false
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1	90.0	Manual_Radar	0	true	false	false
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1	92.0	MAD	0	true	false	false
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1	102.0	MAD	0	true	false	false
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1	132.0	MAD	0	true	false	false
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1	142.0	MAD	0	true	false	false
2	142.0	MAD	0	true	false	false
1	144.0	VISUAL	0	true	false	false
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1	150.0	Manual_Radar	0	true	false	false
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1	162.0	MAD	0	true	false	false
2	162.0	MAD	0	true	false	false
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1	200.0	Manual_Radar	0	true	false	false
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1	212.0	MAD	0	true	false	false
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1	222.0	MAD	0	true	false	false
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1	232.0	MAD	0	true	false	false
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1	242.0	MAD	0	true	false	false
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1	252.0	MAD	0	true	false	false
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1	262.0	MAD	0	true	false	false
2	262.0	MAD	0	true	false	false
1	264.0	VISUAL	0	true	false	false
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1	270.0	Manual_Radar	0	true	false	false
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1	272.0	MAD	0	true	false	false
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1	282.0	MAD	0	true	false	false
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1	290.0	Manual_Radar	0	true	false	false
2	290.0	Manual_Radar	0	true	false	false
1	292.0	MAD	0	true	false	false
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1	302.0	MAD	0	true	false	false
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1	322.0	MAD	0	true	false	false
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1	330.0	Manual_Radar	0	true	false	false
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1	332.0	MAD	0	true	false	false
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1	382.0	MAD	0	true	false	false
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1	390.0	Manual_Radar	0	true	false	false
2	390.0	Manual_Radar	0	true	false	false
1	392.0	MAD	0	true	false	false
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1	400.0	Manual_Radar	0	true	false	false
2	400.0	Manual_Radar	0	true	false	false
1	402.0	MAD	0	true	false	false
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1	420.0	Manual_Radar	0	true	false	false
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1	422.0	MAD	0	true	false	false
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1	430.0	Manual_Radar	0	true	false	false
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1	432.0	MAD	0	true	false	false
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1	442.0	MAD	0	true	false	false
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1	470.0	Manual_Radar	0	true	false	false
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1	482.0	MAD	0	true	false	false
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1	480.0	Manual_Radar	0	true	false	false
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1	492.0	MAD	0	true	false	false
2	492.0	MAD	0	true	false	false
1	490.0	Manual_Radar	0	true	false	false
2	490.0	Manual_Radar	0	true	false	false
1	492.0	MAD	0	true	false	false
2	492.0	MAD	0	true	false	false
1	500.0	Manual_Radar	0	true	false	false
2	500.0	Manual_Radar	0	true	false	false
1	502.0	MAD	0	true	false	false
2	502.0	MAD	0	true	false	false
1	504.0	VISUAL	0	true	false	false
2	504.0	VISUAL	0	true	false	false
1	510.0	Manual_Radar	0	true	false	false
2	510.0	Manual_Radar	0	true	false	false
1	512.0	MAD	0	true	false	false
2	512.0	MAD	0	true	false	false
1	520.0	Manual_Radar	0	true	false	false
2	520.0	Manual_Radar	0	true	false	false
1	522.0	MAD	0	true	false	false
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1	530.0	Manual_Radar	0	true	false	false
2	530.0	Manual_Radar	0	true	false	false
1	532.0	MAD	0	true	false	false
2	532.0	MAD	0	true	false	false
1	540.0	Manual_Radar	0	true	false	false
2	540.0	Manual_Radar	0	true	false	false
1	542.0	MAD	0	true	false	false
2	542.0	MAD	0	true	false	false
1	550.0	Manual_Radar	0	true	false	false
2	550.0	Manual_Radar	0	true	false	false
1	552.0	MAD	0	true	false	false
2	552.0	MAD	0	true	false	false

1	560.0	Manual_Radar	0	true	false	false
2	560.0	Manual_Radar	0	true	false	false
1	562.0	MAD	0	true	false	false
2	562.0	MAD	0	true	false	false
1	570.0	Manual_Radar	0	true	false	false
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1	590.0	Manual_Radar	0	true	false	false
2	590.0	Manual_Radar	0	true	false	false
1	592.0	MAD	0	true	false	false
2	592.0	MAD	0	true	false	false
1	600.0	Manual_Radar	0	true	false	false
2	600.0	Manual_Radar	0	true	false	false
1	602.0	MAD	0	true	false	false
2	602.0	MAD	0	true	false	false
1	610.0	Manual_Radar	0	true	false	false
2	610.0	Manual_Radar	0	true	false	false
1	612.0	MAD	0	true	false	false
2	612.0	MAD	0	true	false	false
1	620.0	Manual_Radar	0	true	false	false
2	620.0	Manual_Radar	0	true	false	false
1	622.0	MAD	0	true	false	false
2	622.0	MAD	0	true	false	false
1	624.0	VISUAL	0	true	false	false
2	624.0	VISUAL	0	true	false	false
1	630.0	Manual_Radar	0	true	false	false
2	630.0	Manual_Radar	0	true	false	false
1	632.0	MAD	0	true	false	false
2	632.0	MAD	0	true	false	false
1	640.0	Manual_Radar	0	true	false	false
2	640.0	Manual_Radar	0	true	false	false
1	642.0	MAD	0	true	false	false
2	642.0	MAD	0	true	false	false
1	650.0	Manual_Radar	0	true	false	false
2	650.0	Manual_Radar	0	true	false	false
1	652.0	MAD	0	true	false	false
2	652.0	MAD	0	true	false	false
1	660.0	Manual_Radar	0	true	false	false
2	660.0	Manual_Radar	0	true	false	false
1	662.0	MAD	0	true	false	false
2	662.0	MAD	0	true	false	false

1	670.0	Manual_Radar	0	true	false	false
2	670.0	Manual_Radar	0	true	false	false
1	672.0	MAD	0	true	false	false
2	672.0	MAD	0	true	false	false
1	680.0	Manual_Radar	0	true	false	false
2	680.0	Manual_Radar	0	true	false	false
1	682.0	MAD	0	true	false	false
2	682.0	MAD	0	true	false	false
1	690.0	Manual_Radar	0	true	false	false
2	690.0	Manual_Radar	0	true	false	false
1	692.0	MAD	0	true	false	false
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1	700.0	Manual_Radar	0	true	false	false
2	700.0	Manual_Radar	0	true	false	false
1	702.0	MAD	0	true	false	false
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1	710.0	Manual_Radar	0	true	false	false
2	710.0	Manual_Radar	0	true	false	false
1	712.0	MAD	0	true	false	false
2	712.0	MAD	0	true	false	false
1	720.0	Manual_Radar	0	true	false	false
2	720.0	Manual_Radar	0	true	false	false
1	722.0	MAD	0	true	false	false
2	722.0	MAD	0	true	false	false
1	730.0	Manual_Radar	0	true	false	false
2	730.0	Manual_Radar	0	true	false	false
1	732.0	MAD	0	true	false	false
2	732.0	MAD	0	true	false	false
1	740.0	Manual_Radar	0	true	false	false
2	740.0	Manual_Radar	0	true	false	false
1	742.0	MAD	0	true	false	false
2	742.0	MAD	0	true	false	false
1	744.0	VISUAL	0	true	false	false
2	744.0	VISUAL	0	true	false	false
1	750.0	Manual_Radar	0	true	false	false
2	750.0	Manual_Radar	0	true	false	false
1	752.0	MAD	0	true	false	false
2	752.0	MAD	0	true	false	false
1	760.0	Manual_Radar	0	true	false	false
2	760.0	Manual_Radar	0	true	false	false
1	762.0	MAD	0	true	false	false
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1	770.0	Manual_Radar	0	true	false	false
2	770.0	Manual_Radar	0	true	false	false
1	722.0	MAD	0	true	false	false
2	722.0	MAD	0	true	false	false

1	780.0	Manual_Radar	0	true	false	false
2	780.0	Manual_Radar	0	true	false	false
1	782.0	MAD	0	true	false	false
2	782.0	MAD	0	true	false	false
1	790.0	Manual_Radar	0	true	false	false
2	790.0	Manual_Radar	0	true	false	false
1	792.0	MAD	0	true	false	false
2	792.0	MAD	0	true	false	false
1	800.0	Manual_Radar	0	true	false	false
2	800.0	Manual_Radar	0	true	false	false
1	802.0	MAD	0	true	false	false
2	802.0	MAD	0	true	false	false
1	810.0	Manual_Radar	0	true	false	false
2	810.0	Manual_Radar	0	true	false	false
1	822.0	MAD	0	true	false	false
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1	820.0	Manual_Radar	0	true	false	false
2	820.0	Manual_Radar	0	true	false	false
1	822.0	MAD	0	true	false	false
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1	830.0	Manual_Radar	0	true	false	false
2	830.0	Manual_Radar	0	true	false	false
1	832.0	MAD	0	true	false	false
2	832.0	MAD	0	true	false	false
1	840.0	Manual_Radar	0	true	false	false
2	840.0	Manual_Radar	0	true	false	false
1	842.0	MAD	0	true	false	false
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2	850.0	Manual_Radar	0	true	false	false
1	852.0	MAD	0	true	false	false
2	852.0	MAD	0	true	false	false
1	860.0	Manual_Radar	0	true	false	false
2	860.0	Manual_Radar	0	true	false	false
1	862.0	MAD	0	true	false	false
2	862.0	MAD	0	true	false	false
1	864.0	VISUAL	0	true	false	false
2	864.0	VISUAL	0	true	false	false
1	870.0	Manual_Radar	0	true	false	false
2	870.0	Manual_Radar	0	true	false	false
1	872.0	MAD	0	true	false	false
2	872.0	MAD	0	true	false	false
1	880.0	Manual_Radar	0	true	false	false
2	880.0	Manual_Radar	0	true	false	false
1	882.0	MAD	0	true	false	false
2	882.0	MAD	0	true	false	false

1	890.0	Manual_Radar	0	true	false	false
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1	892.0	MAD	0	true	false	false
2	892.0	MAD	0	true	false	false
1	900.0	Manual_Radar	0	true	false	false
2	900.0	Manual_Radar	0	true	false	false
1	902.0	MAD	0	true	false	false
2	902.0	MAD	0	true	false	false
1	910.0	Manual_Radar	0	true	false	false
2	910.0	Manual_Radar	0	true	false	false
1	912.0	MAD	0	true	false	false
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1	922.0	MAD	0	true	false	false
2	922.0	MAD	0	true	false	false
1	930.0	Manual_Radar	0	true	false	false
2	930.0	Manual_Radar	0	true	false	false
1	932.0	MAD	0	true	false	false
2	932.0	MAD	0	true	false	false
1	940.0	Manual_Radar	0	true	false	false
2	940.0	Manual_Radar	0	true	false	false
1	942.0	MAD	0	true	false	false
2	942.0	MAD	0	true	false	false
1	950.0	Manual_Radar	0	true	false	false
2	950.0	Manual_Radar	0	true	false	false
1	952.0	MAD	0	true	false	false
2	952.0	MAD	0	true	false	false
1	960.0	Manual_Radar	0	true	false	false
2	960.0	Manual_Radar	0	true	false	false
1	962.0	MAD	0	true	false	false
2	962.0	MAD	0	true	false	false
1	970.0	Manual_Radar	0	true	false	false
2	970.0	Manual_Radar	0	true	false	false
1	972.0	MAD	0	true	false	false
2	972.0	MAD	0	true	false	false
1	980.0	Manual_Radar	0	true	false	false
2	980.0	Manual_Radar	0	true	false	false
1	982.0	MAD	0	true	false	false
2	982.0	MAD	0	true	false	false
1	984.0	VISUAL	0	true	false	false
2	984.0	VISUAL	0	true	false	false
1	990.0	Manual_Radar	0	true	false	false
2	990.0	Manual_Radar	0	true	false	false
1	992.0	MAD	0	true	false	false
2	992.0	MAD	0	true	false	false

1	1000.0	Manual_Radar	0	true	false	false
2	1000.0	Manual_Radar	0	true	false	false
1	1002.0	MAD	0	true	false	false
2	1002.0	MAD	0	true	false	false
1	1010.0	Manual_Radar	0	true	false	false
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1	1012.0	MAD	0	true	false	false
2	1012.0	MAD	0	true	false	false
1	1020.0	Manual_Radar	0	true	false	false
2	1020.0	Manual_Radar	0	true	false	false
1	1022.0	MAD	0	true	false	false
2	1022.0	MAD	0	true	false	false
1	1030.0	Manual_Radar	0	true	false	false
2	1030.0	Manual_Radar	0	true	false	false
1	1032.0	MAD	0	true	false	false
2	1032.0	MAD	0	true	false	false
1	1040.0	Manual_Radar	0	true	false	false
2	1040.0	Manual_Radar	0	true	false	false
1	1042.0	MAD	0	true	false	false
2	1042.0	MAD	0	true	false	false
1	1050.0	Manual_Radar	0	true	false	false
2	1050.0	Manual_Radar	0	true	false	false
1	1052.0	MAD	0	true	false	false
2	1052.0	MAD	0	true	false	false
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1	1062.0	MAD	0	true	false	false
2	1062.0	MAD	0	true	false	false
1	1070.0	Manual_Radar	0	true	false	false
2	1070.0	Manual_Radar	0	true	false	false
1	1072.0	MAD	0	true	false	false
2	1072.0	MAD	0	true	false	false
1	1080.0	Manual_Radar	0	true	false	false
2	1080.0	Manual_Radar	0	true	false	false
1	1082.0	MAD	0	true	false	false
2	1082.0	MAD	0	true	false	false
1	1090.0	Manual_Radar	0	true	false	false
2	1090.0	Manual_Radar	0	true	false	false
1	1092.0	MAD	0	true	false	false
2	1092.0	MAD	0	true	false	false
1	1100.0	Manual_Radar	0	true	false	false
2	1100.0	Manual_Radar	0	true	false	false
1	1102.0	MAD	0	true	false	false
2	1102.0	MAD	0	true	false	false
1	1104.0	VISUAL	0	true	false	false
2	1104.0	VISUAL	0	true	false	false

1	1110.0	Manual_Radar	0	true	false	false
2	1110.0	Manual_Radar	0	true	false	false
1	1112.0	MAD	0	true	false	false
2	1112.0	MAD	0	true	false	false
1	1120.0	Manual_Radar	0	true	false	false
2	1120.0	Manual_Radar	0	true	false	false
1	1122.0	MAD	0	true	false	false
2	1122.0	MAD	0	true	false	false
1	1130.0	Manual_Radar	0	true	false	false
2	1130.0	Manual_Radar	0	true	false	false
1	1132.0	MAD	0	true	false	false
2	1132.0	MAD	0	true	false	false
1	1140.0	Manual_Radar	0	true	false	false
2	1140.0	Manual_Radar	0	true	false	false
1	1142.0	MAD	0	true	false	false
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1	1150.0	Manual_Radar	0	true	false	false
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2	1152.0	MAD	0	true	false	false
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2	1160.0	Manual_Radar	0	true	false	false
1	1162.0	MAD	0	true	false	false
2	1162.0	MAD	0	true	false	false
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1	1172.0	MAD	0	true	false	false
2	1172.0	MAD	0	true	false	false
1	1180.0	Manual_Radar	0	true	false	false
2	1180.0	Manual_Radar	0	true	false	false
1	1182.0	MAD	0	true	false	false
2	1182.0	MAD	0	true	false	false
1	1190.0	Manual_Radar	0	true	false	false
2	1190.0	Manual_Radar	0	true	false	false
1	1192.0	MAD	0	true	false	false
2	1192.0	MAD	0	true	false	false
1	1200.0	Manual_Radar	0	true	false	false
2	1200.0	Manual_Radar	0	true	false	false
1	1202.0	MAD	0	true	false	false
2	1202.0	MAD	0	true	false	false
1	1210.0	Manual_Radar	0	true	false	false
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1	1212.0	MAD	0	true	false	false
2	1212.0	MAD	0	true	false	false
1	1220.0	Manual_Radar	0	true	false	false
2	1220.0	Manual_Radar	0	true	false	false

1	1222.0	MAD	0	true	false	false
2	1222.0	MAD	0	true	false	false
1	1224.0	VISUAL	0	true	false	false
2	1224.0	VISUAL	0	true	false	false
1	1230.0	Manual_Radar	0	true	false	false
2	1230.0	Manual_Radar	0	true	false	false
1	1232.0	MAD	0	true	false	false
2	1232.0	MAD	0	true	false	false
1	1240.0	Manual_Radar	0	true	false	false
2	1240.0	Manual_Radar	0	true	false	false
1	1242.0	MAD	0	true	false	false
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1	1252.0	MAD	0	true	false	false
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1	1262.0	MAD	0	true	false	false
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1	1270.0	Manual_Radar	0	true	false	false
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1	1272.0	MAD	0	true	false	false
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1	1280.0	Manual_Radar	0	true	false	false
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1	1282.0	MAD	0	true	false	false
2	1282.0	MAD	0	true	false	false
1	1290.0	Manual_Radar	0	true	false	false
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1	1302.0	MAD	0	true	false	false
2	1302.0	MAD	0	true	false	false
1	1310.0	Manual_Radar	0	true	false	false
2	1310.0	Manual_Radar	0	true	false	false
1	1312.0	MAD	0	true	false	false
2	1312.0	MAD	0	true	false	false
1	1320.0	Manual_Radar	0	true	false	false
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1	1322.0	MAD	0	true	false	false
2	1322.0	MAD	0	true	false	false
1	1330.0	Manual_Radar	0	true	false	false
2	1330.0	Manual_Radar	0	true	false	false

1	1332.0	MAD	0	true	false	false
2	1332.0	MAD	0	true	false	false
1	1340.0	Manual_Radar	0	true	false	false
2	1340.0	Manual_Radar	0	true	false	false
1	1342.0	MAD	0	true	false	false
2	1342.0	MAD	0	true	false	false
1	1344.0	VISUAL	0	true	false	false
2	1344.0	VISUAL	0	true	false	false
1	1350.0	Manual_Radar	0	true	false	false
2	1350.0	Manual_Radar	0	true	false	false
1	1352.0	MAD	0	true	false	false
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2	1362.0	MAD	0	true	false	false
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2	1370.0	Manual_Radar	0	true	false	false
1	1372.0	MAD	0	true	false	false
2	1372.0	MAD	0	true	false	false
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2	1382.0	MAD	0	true	false	false
1	1390.0	Manual_Radar	0	true	false	false
2	1390.0	Manual_Radar	0	true	false	false
1	1392.0	MAD	0	true	false	false
2	1392.0	MAD	0	true	false	false
1	1400.0	Manual_Radar	0	true	false	false
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1	1402.0	MAD	0	true	false	false
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1	1410.0	Manual_Radar	0	true	false	false
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1	1412.0	MAD	0	true	false	false
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1	1420.0	Manual_Radar	0	true	false	false
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1	1422.0	MAD	0	true	false	false
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1	1432.0	MAD	0	true	false	false
2	1432.0	MAD	0	true	false	false
1	1440.0	Manual_Radar	0	true	false	false
2	1440.0	Manual_Radar	0	true	false	false

1	1442.0	MAD	0	true	false	false
2	1442.0	MAD	0	true	false	false
1	1450.0	Manual_Radar	0	true	false	false
2	1450.0	Manual_Radar	0	true	false	false
1	1452.0	MAD	0	true	false	false
2	1452.0	MAD	0	true	false	false
1	1460.0	Manual_Radar	0	true	false	false
2	1460.0	Manual_Radar	0	true	false	false
1	1462.0	MAD	0	true	false	false
2	1462.0	MAD	0	true	false	false
1	1464.0	VISUAL	0	true	false	false
2	1464.0	VISUAL	0	true	false	false
1	1470.0	Manual_Radar	0	true	false	false
2	1470.0	Manual_Radar	0	true	false	false
1	1472.0	MAD	0	true	false	false
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1	1480.0	Manual_Radar	0	true	false	false
2	1480.0	Manual_Radar	0	true	false	false
1	1482.0	MAD	0	true	false	false
2	1482.0	MAD	0	true	false	false
1	1490.0	Manual_Radar	0	true	false	false
2	1490.0	Manual_Radar	0	true	false	false
1	1492.0	MAD	0	true	false	false
2	1492.0	MAD	0	true	false	false
1	1500.0	Manual_Radar	0	true	false	false
2	1500.0	Manual_Radar	0	true	false	false
1	1502.0	MAD	0	true	false	false
2	1502.0	MAD	0	true	false	false
1	1510.0	Manual_Radar	0	true	false	false
2	1510.0	Manual_Radar	0	true	false	false
1	1512.0	MAD	0	true	false	false
2	1512.0	MAD	0	true	false	false
1	1520.0	Manual_Radar	0	true	false	false
2	1520.0	Manual_Radar	0	true	false	false
1	1522.0	MAD	0	true	false	false
2	1522.0	MAD	0	true	false	false
1	1530.0	Manual_Radar	0	true	false	false
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1	1532.0	MAD	0	true	false	false
2	1532.0	MAD	0	true	false	false
1	1540.0	Manual_Radar	0	true	false	false
2	1540.0	Manual_Radar	0	true	false	false
1	1542.0	MAD	0	true	false	false
2	1542.0	MAD	0	true	false	false
1	1550.0	Manual_Radar	0	true	false	false
2	1550.0	Manual_Radar	0	true	false	false

1	1552.0	MAD	0	true	false	false
2	1552.0	MAD	0	true	false	false
1	1560.0	Manual_Radar	0	true	false	false
2	1560.0	Manual_Radar	0	true	false	false
1	1562.0	MAD	0	true	false	false
2	1572.0	MAD	0	true	false	false
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1	1580.0	Manual_Radar	0	true	false	false
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1	1582.0	MAD	0	true	false	false
2	1582.0	MAD	0	true	false	false
1	1584.0	VISUAL	0	true	false	false
2	1584.0	VISUAL	0	true	false	false
1	1590.0	Manual_Radar	0	true	false	false
2	1590.0	Manual_Radar	0	true	false	false
1	1592.0	MAD	0	true	false	false
2	1592.0	MAD	0	true	false	false
1	1600.0	Manual_Radar	0	true	false	false
2	1600.0	Manual_Radar	0	true	false	false
1	1602.0	MAD	0	true	false	false
2	1602.0	MAD	0	true	false	false
1	1610.0	Manual_Radar	0	true	false	false
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1	1612.0	MAD	0	true	false	false
2	1612.0	MAD	0	true	false	false
1	1620.0	Manual_Radar	0	true	false	false
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2	1632.0	MAD	0	true	false	false
1	1640.0	Manual_Radar	0	true	false	false
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1	1642.0	MAD	0	true	false	false
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1	1650.0	Manual_Radar	0	true	false	false
2	1650.0	Manual_Radar	0	true	false	false
1	1652.0	MAD	0	true	false	false
2	1652.0	MAD	0	true	false	false
1	1660.0	Manual_Radar	0	true	false	false
2	1660.0	Manual_Radar	0	true	false	false

1	1662.0	MAD	0	true	false	false
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1	1670.0	Manual_Radar	0	true	false	false
2	1670.0	Manual_Radar	0	true	false	false
1	1672.0	MAD	0	true	false	false
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1	1702.0	MAD	0	true	false	false
2	1702.0	MAD	0	true	false	false
1	1704.0	VISUAL	0	true	false	false
2	1704.0	VISUAL	0	true	false	false
1	1710.0	Manual_Radar	0	true	false	false
2	1710.0	Manual_Radar	0	true	false	false
1	1712.0	MAD	0	true	false	false
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1	1732.0	MAD	0	true	false	false
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1	1762.0	MAD	0	true	false	false
2	1762.0	MAD	0	true	false	false
1	1770.0	Manual_Radar	0	true	false	false
2	1770.0	Manual_Radar	0	true	false	false

1	1772.0	MAD	0	true	false	false
2	1772.0	MAD	0	true	false	false
1	1780.0	Manual_Radar	0	true	false	false
2	1780.0	Manual_Radar	0	true	false	false
1	1782.0	MAD	0	true	false	false
2	1782.0	MAD	0	true	false	false
1	1790.0	Manual_Radar	0	true	false	false
2	1790.0	Manual_Radar	0	true	false	false
1	1792.0	MAD	0	true	false	false
2	1792.0	MAD	0	true	false	false
1	1800.0	Manual_Radar	0	true	false	false
2	1800.0	Manual_Radar	0	true	false	false
1	1802.0	MAD	0	true	false	false
2	1802.0	MAD	0	true	false	false

0
No_Action

No_Action

trash

Assign_NATO_Name 45.0
May be Correlation alert.

deterministic
1800.0 1450

1	20.0	MAD	0	true	false	false
2	22.0	Manual_Radar	0	true	false	false
3	24.0	VISUAL	0	true	false	false
1	30.0	MAD	0	true	false	false
2	32.0	Manual_Radar	0	true	false	false
1	40.0	MAD	0	true	false	false
2	42.0	Manual_Radar	0	true	false	false
1	50.0	MAD	0	true	false	false
2	52.0	Manual_Radar	0	true	false	false
1	60.0	MAD	0	true	false	false
2	62.0	Manual_Radar	0	true	false	false
1	70.0	MAD	0	true	false	false
2	72.0	Manual_Radar	0	true	false	false
1	80.0	MAD	0	true	false	false
2	82.0	Manual_Radar	0	true	false	false
1	90.0	MAD	0	true	false	false
2	92.0	Manual_Radar	0	true	false	false
1	100.0	MAD	0	true	false	false
2	102.0	Manual_Radar	0	true	false	false
1	120.0	MAD	0	true	false	false
2	122.0	Manual_Radar	0	true	false	false
3	124.0	VISUAL	0	true	false	false
1	130.0	MAD	0	true	false	false
2	132.0	Manual_Radar	0	true	false	false
1	140.0	MAD	0	true	false	false
2	142.0	Manual_Radar	0	true	false	false
1	150.0	MAD	0	true	false	false
2	152.0	Manual_Radar	0	true	false	false
1	160.0	MAD	0	true	false	false
2	162.0	Manual_Radar	0	true	false	false
1	170.0	MAD	0	true	false	false
2	172.0	Manual_Radar	0	true	false	false
1	180.0	MAD	0	true	false	false
2	182.0	Manual_Radar	0	true	false	false
1	190.0	MAD	0	true	false	false
2	192.0	Manual_Radar	0	true	false	false
1	200.0	MAD	0	true	false	false
2	202.0	Manual_Radar	0	true	false	false
1	220.0	MAD	0	true	false	false
2	222.0	Manual_Radar	0	true	false	false
1	230.0	MAD	0	true	false	false
2	232.0	Manual_Radar	0	true	false	false

1	240.0	MAD	0	true	false	false
2	242.0	Manual_Radar	0	true	false	false
3	244.0	VISUAL	0	true	false	false
1	250.0	MAD	0	true	false	false
2	252.0	Manual_Radar	0	true	false	false
1	260.0	MAD	0	true	false	false
2	262.0	Manual_Radar	0	true	false	false
1	270.0	MAD	0	true	false	false
2	272.0	Manual_Radar	0	true	false	false
1	280.0	MAD	0	true	false	false
2	282.0	Manual_Radar	0	true	false	false
1	290.0	MAD	0	true	false	false
2	292.0	Manual_Radar	0	true	false	false
1	300.0	MAD	0	true	false	false
2	302.0	Manual_Radar	0	true	false	false
1	320.0	MAD	0	true	false	false
2	322.0	Manual_Radar	0	true	false	false
1	330.0	MAD	0	true	false	false
2	332.0	Manual_Radar	0	true	false	false
1	340.0	MAD	0	true	false	false
2	342.0	Manual_Radar	0	true	false	false
1	350.0	MAD	0	true	false	false
2	352.0	Manual_Radar	0	true	false	false
1	360.0	MAD	0	true	false	false
2	362.0	Manual_Radar	0	true	false	false
3	364.0	VISUAL	0	true	false	false
1	370.0	MAD	0	true	false	false
2	372.0	Manual_Radar	0	true	false	false
1	380.0	MAD	0	true	false	false
2	382.0	Manual_Radar	0	true	false	false
1	390.0	MAD	0	true	false	false
2	392.0	Manual_Radar	0	true	false	false
1	400.0	MAD	0	true	false	false
2	402.0	Manual_Radar	0	true	false	false
1	420.0	MAD	0	true	false	false
2	422.0	Manual_Radar	0	true	false	false
1	430.0	MAD	0	true	false	false
2	432.0	Manual_Radar	0	true	false	false
1	440.0	MAD	0	true	false	false
2	442.0	Manual_Radar	0	true	false	false
1	450.0	MAD	0	true	false	false
2	452.0	Manual_Radar	0	true	false	false
1	460.0	MAD	0	true	false	false
2	462.0	Manual_Radar	0	true	false	false
1	470.0	MAD	0	true	false	false
2	472.0	Manual_Radar	0	true	false	false

1	480.0	MAD	0	true	false	false
2	482.0	Manual_Radar	0	true	false	false
3	484.0	VISUAL	0	true	false	false
1	490.0	MAD	0	true	false	false
2	492.0	Manual_Radar	0	true	false	false
1	500.0	MAD	0	true	false	false
2	502.0	Manual_Radar	0	true	false	false
1	520.0	MAD	0	true	false	false
2	522.0	Manual_Radar	0	true	false	false
1	530.0	MAD	0	true	false	false
2	532.0	Manual_Radar	0	true	false	false
1	540.0	MAD	0	true	false	false
2	542.0	Manual_Radar	0	true	false	false
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2	562.0	Manual_Radar	0	true	false	false
1	570.0	MAD	0	true	false	false
2	572.0	Manual_Radar	0	true	false	false
1	580.0	MAD	0	true	false	false
2	582.0	Manual_Radar	0	true	false	false
1	590.0	MAD	0	true	false	false
2	592.0	Manual_Radar	0	true	false	false
1	600.0	MAD	0	true	false	false
2	602.0	Manual_Radar	0	true	false	false
3	604.0	VISUAL	0	true	false	false
1	620.0	MAD	0	true	false	false
2	622.0	Manual_Radar	0	true	false	false
1	630.0	MAD	0	true	false	false
2	632.0	Manual_Radar	0	true	false	false
1	640.0	MAD	0	true	false	false
2	642.0	Manual_Radar	0	true	false	false
1	650.0	MAD	0	true	false	false
2	652.0	Manual_Radar	0	true	false	false
1	660.0	MAD	0	true	false	false
2	662.0	Manual_Radar	0	true	false	false
1	670.0	MAD	0	true	false	false
2	672.0	Manual_Radar	0	true	false	false
1	680.0	MAD	0	true	false	false
2	682.0	Manual_Radar	0	true	false	false
1	690.0	MAD	0	true	false	false
2	692.0	Manual_Radar	0	true	false	false
1	700.0	MAD	0	true	false	false
2	702.0	Manual_Radar	0	true	false	false
1	720.0	MAD	0	true	false	false
2	722.0	Manual_Radar	0	true	false	false

3	724.0	VISUAL	0	true	false	false
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1	740.0	MAD	0	true	false	false
2	742.0	Manual_Radar	0	true	false	false
1	750.0	MAD	0	true	false	false
2	752.0	Manual_Radar	0	true	false	false
1	760.0	MAD	0	true	false	false
2	762.0	Manual_Radar	0	true	false	false
1	770.0	MAD	0	true	false	false
2	772.0	Manual_Radar	0	true	false	false
1	780.0	MAD	0	true	false	false
2	782.0	Manual_Radar	0	true	false	false
1	790.0	MAD	0	true	false	false
2	792.0	Manual_Radar	0	true	false	false
1	800.0	MAD	0	true	false	false
2	802.0	Manual_Radar	0	true	false	false
1	820.0	MAD	0	true	false	false
2	822.0	Manual_Radar	0	true	false	false
1	830.0	MAD	0	true	false	false
2	832.0	Manual_Radar	0	true	false	false
1	840.0	MAD	0	true	false	false
2	842.0	Manual_Radar	0	true	false	false
3	844.0	VISUAL	0	true	false	false
1	850.0	MAD	0	true	false	false
2	852.0	Manual_Radar	0	true	false	false
1	860.0	MAD	0	true	false	false
2	862.0	Manual_Radar	0	true	false	false
1	870.0	MAD	0	true	false	false
2	872.0	Manual_Radar	0	true	false	false
1	880.0	MAD	0	true	false	false
2	882.0	Manual_Radar	0	true	false	false
1	890.0	MAD	0	true	false	false
2	892.0	Manual_Radar	0	true	false	false
1	900.0	MAD	0	true	false	false
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1	920.0	MAD	0	true	false	false
2	922.0	Manual_Radar	0	true	false	false
1	930.0	MAD	0	true	false	false
2	932.0	Manual_Radar	0	true	false	false
1	940.0	MAD	0	true	false	false
2	942.0	Manual_Radar	0	true	false	false
1	950.0	MAD	0	true	false	false
2	952.0	Manual_Radar	0	true	false	false
1	960.0	MAD	0	true	false	false
2	962.0	Manual_Radar	0	true	false	false

3	964.0	VISUAL	0	true	false	false
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2	972.0	Manual_Radar	0	true	false	false
1	980.0	MAD	0	true	false	false
2	982.0	Manual_Radar	0	true	false	false
1	990.0	MAD	0	true	false	false
2	992.0	Manual_Radar	0	true	false	false
1	1000.0	MAD	0	true	false	false
2	1002.0	Manual_Radar	0.	true	false	false
1	1020.0	MAD	0	true	false	false
2	1022.0	Manual_Radar	0	true	false	false
1	1030.0	MAD	0	true	false	false
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1	1080.0	MAD	0	true	false	false
2	1082.0	Manual_Radar	0	true	false	false
3	1084.0	VISUAL	0	true	false	false
1	1090.0	MAD	0	true	false	false
2	1092.0	Manual_Radar	0	true	false	false
1	1100.0	MAD	0	true	false	false
2	1102.0	Manual_Radar	0	true	false	false
1	1120.0	MAD	0	true	false	false
2	1122.0	Manual_Radar	0	true	false	false
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2	1152.0	Manual_Radar	0	true	false	false
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2	1172.0	Manual_Radar	0	true	false	false
1	1180.0	MAD	0	true	false	false
2	1182.0	Manual_Radar	0	true	false	false
1	1190.0	MAD	0	true	false	false
2	1192.0	Manual_Radar	0	true	false	false
1	1200.0	MAD	0	true	false	false
2	1202.0	Manual_Radar	0	true	false	false

3	1204.0	VISUAL	0	true	false	false
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1	1320.0	MAD	0	true	false	false
2	1322.0	Manual_Radar	0	true	false	false
3	1324.0	VISUAL	0	true	false	false
1	1330.0	MAD	0	true	false	false
2	1332.0	Manual_Radar	0	true	false	false
1	1340.0	MAD	0	true	false	false
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2	1392.0	Manual_Radar	0	true	false	false
1	1400.0	MAD	0	true	false	false
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2	1422.0	Manual_Radar	0	true	false	false
1	1430.0	MAD	0	true	false	false
2	1432.0	Manual_Radar	0	true	false	false
1	1440.0	MAD	0	true	false	false
2	1442.0	Manual_Radar	0	true	false	false
3	1444.0	VISUAL	0	true	false	false
1	1450.0	MAD	0	true	false	false

2	1452.0	Manual_Radar	0	true	false	false
1	1460.0	MAD	0	true	false	false
2	1462.0	Manual_Radar	0	true	false	false
1	1470.0	MAD	0	true	false	false
2	1472.0	Manual_Radar	0	true	false	false
1	1480.0	MAD	0	true	false	false
2	1482.0	Manual_Radar	0	true	false	false
1	1490.0	MAD	0	true	false	false
2	1492.0	Manual_Radar	0	true	false	false
1	1500.0	MAD	0	true	false	false
2	1502.0	Manual_Radar	0	true	false	false
1	1520.0	MAD	0	true	false	false
2	1522.0	Manual_Radar	0	true	false	false
1	1530.0	MAD	0	true	false	false
2	1532.0	Manual_Radar	0	true	false	false
1	1540.0	MAD	0	true	false	false
2	1542.0	Manual_Radar	0	true	false	false
1	1550.0	MAD	0	true	false	false
2	1552.0	Manual_Radar	0	true	false	false
1	1560.0	MAD	0	true	false	false
2	1562.0	Manual_Radar	0	true	false	false
3	1564.0	VISUAL	0	true	false	false
1	1570.0	MAD	0	true	false	false
2	1572.0	Manual_Radar	0	true	false	false
1	1580.0	MAD	0	true	false	false
2	1582.0	Manual_Radar	0	true	false	false
1	1590.0	MAD	0	true	false	false
2	1592.0	Manual_Radar	0	true	false	false
1	1600.0	MAD	0	true	false	false
2	1602.0	Manual_Radar	0	true	false	false
1	1620.0	MAD	0	true	false	false
2	1622.0	Manual_Radar	0	true	false	false
1	1630.0	MAD	0	true	false	false
2	1632.0	Manual_Radar	0	true	false	false
1	1640.0	MAD	0	true	false	false
2	1642.0	Manual_Radar	0	true	false	false
1	1650.0	MAD	0	true	false	false
2	1652.0	Manual_Radar	0	true	false	false
1	1660.0	MAD	0	true	false	false
2	1662.0	Manual_Radar	0	true	false	false
1	1670.0	MAD	0	true	false	false
2	1672.0	Manual_Radar	0	true	false	false
1	1680.0	MAD	0	true	false	false
2	1682.0	Manual_Radar	0	true	false	false
3	1684.0	VISUAL	0	true	false	false
1	1690.0	MAD	0	true	false	false

2	1692.0	Manual_Radar	0	true	false	false
1	1700.0	MAD	0	true	false	false
2	1702.0	Manual_Radar	0	true	false	false
1	1720.0	MAD	0	true	false	false
2	1722.0	Manual_Radar	0	true	false	false
1	1730.0	MAD	0	true	false	false
2	1732.0	Manual_Radar	0	true	false	false
1	1740.0	MAD	0	true	false	false
2	1742.0	Manual_Radar	0	true	false	false
1	1750.0	MAD	0	true	false	false
2	1752.0	Manual_Radar	0	true	false	false
1	1760.0	MAD	0	true	false	false
2	1762.0	Manual_Radar	0	true	false	false
1	1770.0	MAD	0	true	false	false
2	1772.0	Manual_Radar	0	true	false	false
1	1780.0	MAD	0	true	false	false
2	1782.0	Manual_Radar	0	true	false	false
1	1790.0	MAD	0	true	false	false
2	1792.0	Manual_Radar	0	true	false	false
1	1800.0	MAD	0	true	false	false
2	1802.0	Manual_Radar	0	true	false	false
3	1804.0	VISUAL	0	true	false	false
1	1820.0	MAD	0	true	false	false
2	1822.0	Manual_Radar	0	true	false	false
1	1830.0	MAD	0	true	false	false
2	1832.0	Manual_Radar	0	true	false	false
1	1840.0	MAD	0	true	false	false
2	1842.0	Manual_Radar	0	true	false	false
1	1850.0	MAD	0	true	false	false
2	1852.0	Manual_Radar	0	true	false	false
1	1860.0	MAD	0	true	false	false
2	1862.0	Manual_Radar	0	true	false	false
1	1870.0	MAD	0	true	false	false
2	1872.0	Manual_Radar	0	true	false	false
1	1880.0	MAD	0	true	false	false
2	1882.0	Manual_Radar	0	true	false	false
1	1890.0	MAD	0	true	false	false
2	1892.0	Manual_Radar	0	true	false	false
1	1900.0	MAD	0	true	false	false
2	1902.0	Manual_Radar	0	true	false	false
1	1920.0	MAD	0	true	false	false
2	1922.0	Manual_Radar	0	true	false	false
3	1924.0	VISUAL	0	true	false	false
1	1930.0	MAD	0	true	false	false
2	1932.0	Manual_Radar	0	true	false	false
1	1940.0	MAD	0	true	false	false

2	1942.0	Manual_Radar	0	true	false	false
1	1950.0	MAD	0	true	false	false
2	1952.0	Manual_Radar	0	true	false	false
1	1960.0	MAD	0	true	false	false
2	1962.0	Manual_Radar	0	true	false	false
1	1970.0	MAD	0	true	false	false
2	1972.0	Manual_Radar	0	true	false	false
1	1980.0	MAD	0	true	false	false
2	1982.0	Manual_Radar	0	true	false	false
1	1990.0	MAD	0	true	false	false
2	1992.0	Manual_Radar	0	true	false	false

0
No_Action

No_Action

trash

Assign_NATO_Name 45.0
May be Correlation alert.

Appendix D

Platform Movement Model Templates

Below is the platform input data template for three targets moving parallel to the aircraft. The aircraft is flying in a racetrack motion.

```
INIT   0
  0.0       0.0        ACalt       188.0
LINE
 300.0      0.0        0.0
ARC
  2.0      RIGHT        0
LINE
 300.0     180.0       0.0
ARC
  2.0      RIGHT        0
LINE
 300.0      0.0        0.0
ARC
  2.0      RIGHT        0
LINE
 300.0     180.0       0.0
ARC
  2.0      RIGHT        0
LINE
 300.0      0.0        0.0
ARC
  2.0      RIGHT        0
LINE
 300.0     180.0       0.0
INIT   1
 T1lat     T1lon        0.0        Tspd
LINE
1800.0     180.0       0.0
INIT   2
 T2lat     T2lon        0.0        Tspd
LINE
1800.0     180.0       0.0
INIT   3
 T3lat     T3lon        0.0        Tspd
LINE
1800.0     180.0       0.0


THE_END
 -1.0
 -1.0
 -1.0
```

-1.0
-1.0
-1.0
-1.0
-1.0

Below is the platform input data template for two targets moving away from the aircraft. The aircraft is flying in a racetrack motion.

```
INIT    0
 0.0       0.0       ACalt      188.0
LINE
 300.0     0.0       0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     180.0     0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     0.0       0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     180.0     0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     0.0       0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     180.0     0.0
INIT    1
 T1lat     T1lon     1000.0     T1spd
LINE
 1800.0    270.0     0.0
INIT    2
 T2lat     T2lon     1000.0     T2spd
LINE
 1800.0    270.0     0.0


THE_END
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
```

-1.0

Below is the platform input data template for two air type targets moving parallel to the aircraft. The aircraft is flying in a racetrack motion.

```
INIT    0
  0.0       0.0        ACalt       188.0
LINE
 300.0      0.0        0.0
ARC
  5.0      RIGHT        0
LINE
 300.0     180.0       0.0
ARC
  5.0      RIGHT        0
LINE
 300.0      0.0        0.0
ARC
  5.0      RIGHT        0
LINE
 300.0     180.0       0.0
ARC
  5.0      RIGHT        0
LINE
 300.0      0.0        0.0
ARC
  5.0      RIGHT        0
LINE
 300.0     180.0       0.0
INIT    1
 T1lat     T1lon      1000.0      T1spd
LINE
 1800.0    180.0       0.0
INIT    2
 T2lat     T2lon      1000.0      T2spd
LINE
 1800.0    180.0       0.0


THE_END
  -1.0
  -1.0
  -1.0
  -1.0
  -1.0
  -1.0
```

-1.0
-1.0

Below is the platform input data template for two targets moving parallel to the aircraft. The aircraft is flying in a racetrack motion.

```
INIT   0
  0.0       0.0        ACalt       188.0
LINE
 300.0       0.0        0.0
ARC
  5.0      RIGHT         0
LINE
 300.0     180.0        0.0
ARC
  5.0      RIGHT         0
LINE
 300.0       0.0        0.0
ARC
  5.0      RIGHT         0
LINE
 300.0     180.0        0.0
ARC
  5.0      RIGHT         0
LINE
 300.0       0.0        0.0
ARC
  5.0      RIGHT         0
LINE
 300.0     180.0        0.0
INIT   1
 T1lat      T1lon        0.0       T1spd
LINE
1800.0     312.0        0.0
INIT   2
 T2lat      T2lon        0.0       T2spd
LINE
1800.0     228.0        0.0


THE_END
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
```

-1.0

Below is the platform input data template for two targets moving in a crisscross motion parallel to the aircraft. The aircraft is flying in a racetrack motion.

```
INIT    0
 0.0       0.0       ACalt      188.0
LINE
 300.0     0.0       0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     180.0     0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     0.0       0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     180.0     0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     0.0       0.0
ARC
 5.0       RIGHT     0
LINE
 300.0     180.0     0.0
INIT    1
 T1lat     T1lon     0.0        T1spd
LINE
 150.0     312.0     -10.0
ARC
 0.001     RIGHT     0
LINE
 150.0     312.0     10.0
INIT    2
 T2lat     T2lon     0.0        T2spd
LINE
 150.0     228.0     -10.0
ARC
 0.001     RIGHT     0
LINE
 150.0     228.0     10.0
```

THE_END
-1.0
-1.0
-1.0
-1.0
-1.0
-1.0
-1.0
-1.0

Below is the platform input data template for one target moving away from the aircraft. The aircraft is flying in a racetrack motion.

```
INIT   0
  0.0        0.0        ACalt      188.0
LINE
  300.0      0.0        0.0
ARC
  5.0        RIGHT      0
LINE
  300.0      180.0      0.0
ARC
  5.0        RIGHT      0
LINE
  300.0      0.0        0.0
ARC
  5.0        RIGHT      0
LINE
  300.0      180.0      0.0
ARC
  5.0        RIGHT      0
LINE
  300.0      0.0        0.0
ARC
  5.0        RIGHT      0
LINE
  300.0      180.0      0.0
INIT   1
  T1lat      T1lon      0.0        T1spd
LINE
  1800.0     270.0      0.0


THE_END
  -1.0
  -1.0
  -1.0
  -1.0
  -1.0
  -1.0
  -1.0
  -1.0
```

Below is the platform input data template for one target moving parallel to the aircraft. The aircraft is flying in a racetrack motion.

```
INIT   0
  0.0       0.0        ACalt      188.0
LINE
  300.0     0.0        0.0
ARC
  5.0       RIGHT      0
LINE
  300.0     180.0      0.0
ARC
  5.0       RIGHT      0
LINE
  300.0     0.0        0.0
ARC
  5.0       RIGHT      0
LINE
  300.0     180.0      0.0
ARC
  5.0       RIGHT      0
LINE
  300.0     0.0        0.0
ARC
  5.0       RIGHT      0
LINE
  300.0     180.0      0.0
INIT   1
  T1lat     T1lon      0.0        T1spd
LINE
 1800.0     180.0      0.0


THE_END
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
```

Below is the platform input data template for two targets moving away from the aircraft. The aircraft is flying in a racetrack motion.

```
INIT    0
 0.0        0.0         ACalt       188.0
LINE
 300.0      0.0         0.0
ARC
 2.0        RIGHT       0
LINE
 300.0      180.0       0.0
ARC
 2.0        RIGHT       0
LINE
 300.0      0.0         0.0
ARC
 2.0        RIGHT       0
LINE
 300.0      180.0       0.0
ARC
 2.0        RIGHT       0
LINE
 300.0      0.0         0.0
ARC
 2.0        RIGHT       0
LINE
 300.0      180.0       0.0
INIT    1
 T1lat      T1lon       0.0         T1spd
LINE
 1800.0     270.0       0.0
INIT    2
 T2lat      T2lon       0.0         T2spd
LINE
 1800.0     270.0       0.0


THE_END
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
```

-1.0

Below is the platform input data template for two targets moving parallel to the aircraft. The aircraft is flying in a racetrack motion.

```
INIT   0
 0.0      0.0      ACalt     188.0
LINE
 300.0    0.0      0.0
ARC
 2.0      RIGHT    0
LINE
 300.0    180.0    0.0
ARC
 2.0      RIGHT    0
LINE
 300.0    0.0      0.0
ARC
 2.0      RIGHT    0
LINE
 300.0    180.0    0.0
ARC
 2.0      RIGHT    0
LINE
 300.0    0.0      0.0
ARC
 2.0      RIGHT    0
LINE
 300.0    180.0    0.0
INIT   1
 T1lat    T1lon    0.0       T1spd
LINE
 1800.0   180.0    0.0
INIT   2
 T2lat    T2lon    0.0       T2spd
LINE
 1800.0   180.0    0.0


THE_END
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
 -1.0
```

-1.0

Appendix E

Production Testbed Execution Script

multi.com

```
#! /bin/csh -f
# multi_run_tb.com   A script file for running the UPDATE IV testbed several times.

# CHH/KCA 8/13/92
# VLB 9/1/92

#


# set up for using ~banowetz/generic/waitproc.com
date > vbowait

# Be sure that the file TSLI_STARTUP is present for.  It is required for
# running multiple tests.
rm TSLI_STARTUP
cp $TESTBED/TSLI_STARTUPhold TSLI_STARTUP
chmod 777 TSLI_STARTUP
if (-e msc.prg) goto cont
  cp $TESTBED/msc.prg msc.prg
  chmod 777 msc.prg
  # also msc.prg must be present since it is referenced by TSLI_STARTUP
cont:

# Set the number of iterations to run
set MAXITER = 50
set MAXITER = 6

echo "Your testbed library is $INTGLIB using $INTGSEL."
echo -n "Enter RETURN if correct, else CTRL C "
set answer = $<

##### CHECK RECORD
  echo "The latest 20 scenario files in this dire are:"
```

```
 ls -lat \!*.a  | head -20
 echo " "

echo " "
echo "The number of iterations is $MAXITER."
echo -n "Enter alternate number of iterations or CR if no change: "
set answer = $<
if ($answer != "") then
 set  MAXITER = $answer
 echo "The number of iterations is $MAXITER."
endif

echo " "
# Set the starting scenario file number (# for sf#.a and sf#.cmd)
set sf_num = 101
echo "The starting scenario file number is $sf_num."
echo -n "Enter alternate scenario file number or CR if no change: "
set answer = $<
if ($answer != "") then
 set sf_num  = $answer
 echo "The starting scenario file number is now $sf_num."
endif


echo " "
echo "This script will run the MSC testbed multiple times"
echo "using a different scenario file for each run."
echo " "
echo "Would you like to append the results to msc_model.accum after"
echo -n "an iteration/run has completed?"
set answer = $<
switch ("$answer")
 case [Yy]:
 case [Yy][Ee][Ss]:
  set do_append = 1
  # Set the accum file number (# for output msc_model.accum)
```

```
  set ACCUM = 0
  echo "The default accum file number to output to is $ACCUM."
  echo -n "Enter alternate accum file number or CR if no change: "
  set answer = $<
  if ($answer != "") then
  set ACCUM  = $answer
  echo "The accum file number is now $ACCUM."
  echo At run termination, the msc_model.accum file will be copied to
 echo msc_model.accum$ACCUM
endif
  breaksw
 case [Nn]:
 case [Nn][Oo]:
  set do_append = 0
  breaksw
 default
  echo "  Huh?  "
  exit 0
  breaksw
endsw

#mz
echo " "
echo "Would you like to use automatic answer?"
echo "Enter  1 to accept split track and correlations except reject correlations for new
fix,"
echo "Enter  0 for NO automatic answer (default), and"
echo "Enter  2 to reject all correlations"

set answer = $<
switch ("$answer")
 case [1]:
  echo "Using generic_input_parameters_accept"
  cp $TESTBED/generic_input_parameters_accept generic_input_parameters
```

```
  breaksw

 case [0]:
  echo "Using generic_input_parameters_no_answer"
  cp $TESTBED/generic_input_parameters_no_answer generic_input_parameters
  breaksw

 case [2]:
  echo "Using generic_input_parameters_reject"
  cp $TESTBED/generic_input_parameters_reject generic_input_parameters
  breaksw

endsw
 echo Auto Accept option is $answer
#end mz

#*************************************************************
#       VARIABLE DEFINITIONS
#*************************************************************



#*************************************************************
        # initialize the counter
set count = 1

if (-e $cwd/TSLI_STARTUP) then
 echo TSLI_STARTUP will be used to select the .prg file.
else
 echo "No TSLI_STARTUP file is in place."
 exit
endif

# Initialize msc_model.accum
echo "msc_model.accum" > msc_model.accum
date            >> msc_model.accum
```

```
echo " " >> test.log
date >> test.log
echo sf$sf_num.a $MAXITER  iters >> test.log

# repeat test $MAXITER times
while ($count <= $MAXITER)

 echo "Starting iteration $count with scenario file sf$sf_num.a"
 # Run testbed selecting the latest version.
 # startup the testbed, supplying a 1 for which version to run
 echo $sf_num > CASE_NUM
 chmod 774 CASE_NUM
 # cat CASE_NUM
 echo "1" | fireupx -a $INTGLIB
 # echo "1" | fireupx -a /local.tb.imet/tms2c -i sf$sf_num.a
 # using TSLI_STARTUP to point to the desired .prg file

 if ($do_append) then
  echo "Concatenating results."
  cat text_extract_file.out >> msc_model.accum
  echo "End_of_iter_run"    >> msc_model.accum
  date >> msc_model.accum
 endif


#****************************************************************************

 # increment the counters
 set count = `expr $count + 1`
 set sf_num = `expr $sf_num + 1`

end

cp msc_model.accum msc_model.accum$ACCUM
echo "End_of_case">> msc_model.accum$ACCUM
```

```
echo msc_model.accum$ACCUM is built.
echo "msc_model.accum$ACCUM is built from $MAXITER iterations." >> test.log

chmod 777 *

echo "MSC iterations are complete by multi_run.com"

enit:
rm -f vbowait
```